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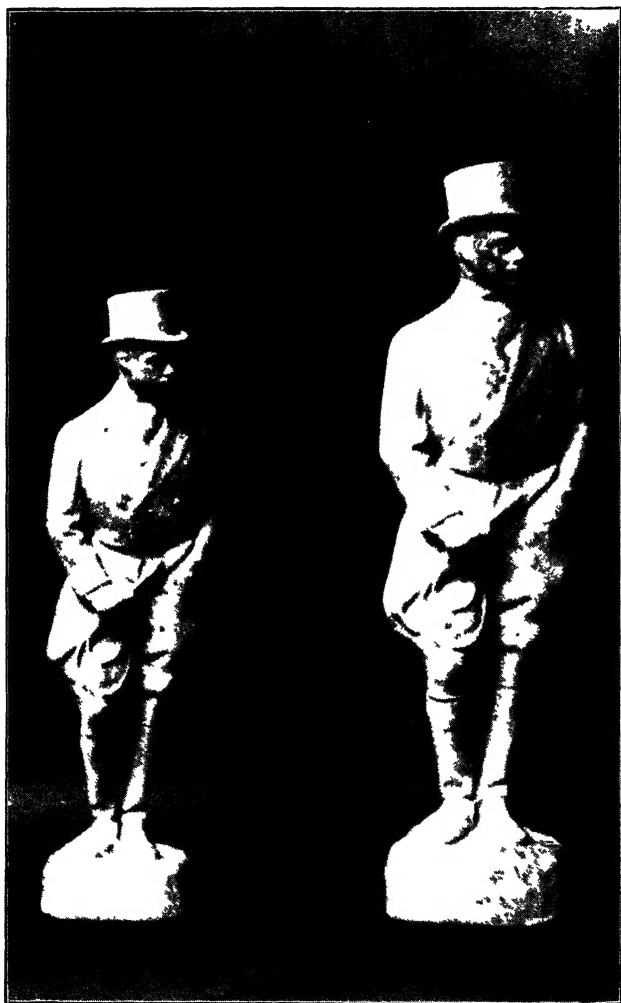
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HOW CHINA CONTRACTS IN FIRING

Figure of the Prince of Wales, by Doulton's, showing the original model, and the figure in china after contracting in the fire

(1462A)



Frontispiece

PITMAN'S COMMON COMMODITIES
AND INDUSTRIES

POTTERY

BEING A SIMPLE ACCOUNT OF THE HISTORY
OF POTTERY AND A DESCRIPTION OF SOME
OF THE PROCESSES EMPLOYED IN ITS
MANUFACTURE

BY
CHARLES J. NOKE
AND
HAROLD J. PLANT



SECOND EDITION

LONDON
SIR ISAAC PITMAN & SONS, LTD.
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PREFACE

TO SECOND EDITION

SINCE the last edition was published some interesting developments have taken place in the British Pottery industry.

This applies particularly to methods of firing, due to some extent to the high price of fuel, and although some of our experts feel justified in thinking that coal will easily hold its own, many manufacturers have now adopted oil with most successful results. Several electrical kilns for firing the colours are now in satisfactory operation, and there is little doubt that these experiments are leading to more economical production in all classes of pottery ware.

We have added to this edition a small glossary explaining technical terms, and a special appendix also on the fire hazards associated with the manufacture of pottery. We trust this will be useful to all interested in this side of the industry.

1927

C. J. N.
H. J. P.

PREFACE

TO FIRST EDITION

THE making of Pottery, with all its fascination and mystery, has such a wide appeal, that one wonders sometimes why there is such a lack of knowledge among the general public with regard to the industry.

If one needs any justification for this book it is in the hope that here may be found, put in as simple language as possible, a description of the various processes and types that will add to the already general interest.

This book is not intended to be a guide for collectors, nor yet a complete treatise, yet it is based on the practical experience and knowledge of a close and intimate connection on the part of both authors with different branches of the trade. Indeed one can claim descent from a race of potters dating back to 1780 or even earlier than this.

Here will be found many hints of value to young potters, and those who have to handle pottery as salesmen may also find matters of value and interest.

The illustrations used of the making processes are of workers engaged in the industry to-day, and help to show more clearly than words alone the processes described.

No attempt has been made to describe in detail the wonderful results, from a potting and art standpoint, attained by the modern British potter. Wonderful these results certainly are, and their true value will probably never be estimated until the makers of to-day have been long since forgotten.

STOKE-ON-TRENT,
1924.

CHAS. J. NOKE
H. J. PLANT

INTRODUCTION

ONE approaches the subject of this work with some diffidence, being aware that the ground to be traversed has been covered many times by writers eminently capable of doing justice to this interesting theme. There is one consolation and hope, however, in the knowledge that no craft makes wider appeal than the one with which we are about to deal.

It is a craft known to all countries and all people, in the East and in the West. From the most remote periods pottery was made to meet the daily needs of all conditions of men. The pots that are dug up in our ancient cities are mostly domestic in character, and in many cases throw some light on the customs of the people of their day.

It is the purpose of this volume to dwell at length upon the quality and character of the pottery itself, and the methods and processes of its manufacture, rather than upon the aesthetic side of the craft, so that the reader may obtain an intelligent and clear idea of the making of the different kinds of ware that one comes across in one's everyday experience. Pottery vessels, even those used in our daily life for ordinary domestic purposes, require many processes in their making, and go through many hands. The designer, the modeller, the mouldmaker, the potter, the fireman, and the dipper all have some part to play in their production from a lump of soft clay to the plate or cup upon one's table. These processes will all be taken in their proper sequence, and will demonstrate the real difficulties of the potter's art. Behind and beyond this art lie the romance and mystery of centuries. Romance, tragedy, adventure,

hope contained in those dark and towering monsters—the ovens—standing in great masses against the evening sky, in whose fiery heart the efforts of craftsmen are burning. Shall they come to him things of delicate beauty or poor distorted cripples, crooked and marred. Picture the heroic figure of Palissy firing his oven with the last of his poor furniture, and tearing up the boards of his floors to maintain the heat until the children of his brain and heart were completely developed, hope alone saving him from despair; or Botcher in his struggles for porcelain; or, nearer our own time, Wedgwood. All the knowledge that makes this common pot of to-day wrested from the consuming flame—The Potter's Art indeed.

Thanks are due to Mr. Chas. R. Skynner, of St. Austell, for particulars of the clay and stone mines of Cornwall; to Messrs. Wm. Boulton, Ltd., the eminent pottery machinery engineers of Burslem; to Mr. Fred Turner for his kindly interest and help; and to Sports and General Press Agency, Ltd., London, for the use of their copyright photographs.

CONTENTS

	PAGE
PREFACE	v
INTRODUCTION	vii
CHAPTER I	
HISTORY OF POTTERY	1
Early pottery—Egyptian—Ancient British—Greek—Chinese—Persian—Majolica—Faience—French—German—Dutch—English	
CHAPTER II	
CHEMISTRY AND POTTERY	21
Definition of pottery—Chemistry and pottery—The winning of materials—Milling—Flints—China stone—Bone ash—Felspar—Glaze—Parian—The drying kiln	
CHAPTER III	
MIXING	45
The sliphouse—Body mixing—Sifters—Magnets—Clay press—Pug mill	
CHAPTER IV	
MANUFACTURE	56
The manufacture of the pottery article—Throwing—Looker to ware—Turning—Handling	
CHAPTER V	
FLAT MAKING	70
Flat making—Standardization of moulds and heads—preparation of clay—Casting—Drying stoves	
CHAPTER VI	
SAGGAR MAKING	80
Saggars and saggar making	

CHAPTER VII

GREENHOUSE AND BISCUIT BAKING 84

Greenhouse and looking over—Biscuit placing—Counting out—Settling—Looking over—Description of oven—Placing hollow-ware—Placing china flatware—Flinting—Bedding—Firing—Pyrometers—Biscuit warehouse—Cleaning china flat—Cleaning hollow-ware

CHAPTER VIII

DIPPING AND GLOST PLACING 97

Dipping—Drying—Ware cleaning—Placing -Cranks—Wad clay—Causes of excessive loss

CHAPTER IX

DESIGNING AND MODELLING 104

Designing and modelling—General principles—Teapot—Dinner plate—Cup, jug, figure—Moulds

CHAPTER X

MOULD MAKING 112

Mould making—General principles—Plaster—Tools—Blocking and casing—Moulds

CHAPTER XI

SOME TYPES OF POTTERY DECORATION 120

Pottery decoration—Underglaze—Enamel—Hand painting—Printing—Lithographing—Slip painting

CHAPTER XII

ENAMEL KILNS 126

Enamel and hardening-on kilns—Preparation—Firing—Placing—Polishing

CHAPTER XIII

COSTING 131

Cost of production—Getting up orders—Stocktaking—Final remarks

GLOSSARY 135

APPENDIX: FIRE HAZARDS ASSOCIATED WITH THE
MANUFACTURE OF CHINA AND EARTHENWARE . 137

INDEX 147

ILLUSTRATIONS

FIG.		PAGE
	HOW CHINA CONTRACTS IN FIRING	<i>Frontispiece</i>
1.	CHINA CLAY PIT	30
2.	ALSING CYLINDER	37
3.	BLUNGER	48
4.	CLAY PRESS	49
5.	CLAY CARRIER	51
6.	PUG MILL	53
7.	THE THROWER	59
8.	MAKING A TEACUP (THROWING)	61
9.	THROWER'S WHEEL	62
10.	TURNING A TEACUP (TURNING)	63
11.	CUP HANDLE MOULD	65
12.	FIXING HANDLE ON CUP	67
13.	SPREADER AND JOLLEY	71
14.	PLATE MAKING	73
15.	CASTING JUGS	75
16.	DRYING STOVE FOR FLAT WARE	78
17.	BEDDING CLAY, FLAT WARE	89
18.	PLACER AND FIREMAN AT WORK	91
19.	DIPPING	98
20.	DRYING TOWER	100
21.	PLACING GLOST WARE	101
22.	THE JESTER	107
23.	THE JESTER BEFORE ASSEMBLING	109
24.	MODELLING	110
25.	MOULD MAKING, THE CUP	117
26.	AN ARTIST	121
27.	PRINTING THE PATTERN ON CUPS AND SAUCERS	123

POTTERY

CHAPTER I

HISTORY OF POTTERY

Once more within the potter's house alone
I stood surrounded by the shapes of clay ;
Shapes of all sizes, great and small,
That stood along the floor and by the wall
And some loquacious vessels were, and some
Listened perhaps, but never talked at all
(*Rubāiyât. Omar Khayyâm*)

THE word Pottery is applied to all articles made or formed of baked clay. It was made in the most remote ages, and all primitive races of the world seem to have used it in some form or other. Made for domestic use the shapes were as a result simple and suitable for their purpose. Before these primitive peoples discovered the method of burning their pots, they dried them in the sun, where they acquired a very considerable degree of hardness. In some cases the vessels were coated with a greasy material rubbed into the surface, which not only gave a very agreeable polish but made them more efficient for holding liquids. One can readily imagine that some of these pottery vessels were placed on or near the fire to warm the contents, and would gradually in this way become really strong and capable of long use, as the body of the earthenware became partly fired.

In Egypt, pottery of various clays was made in the very early periods of the nation, perhaps the best known of this kind being the wonderful little Ushabti figures,

buried in the tombs with the dead, being supposed to act as attendants to the deceased in his or her journeyings to the other world. These little figures date back to 2000 or 3000 B.C., and are often of wonderful and beautiful character and colour. The modelling in many of them is extremely fine and delicate, and many of the Egyptian figures could not be excelled for quality of workmanship in the present day. They vary in size from almost an inch to nearly a foot in height ; some are unglazed, the body being of a very coarse and sandy nature, which makes the fine modelling still more remarkable.

There must have been a very considerable industry for figures of all kinds, as they were made in large quantities and are still found in large numbers. The colours were mostly of a deep turquoise blue obtained from copper oxide, in some cases very brilliant with added black markings, and in others green and very thinly glazed. Examples can be seen of work in which a very fine character has been obtained. The Egyptian potters also had the secret of much finer clays, mostly of a red colour varying to yellow, with which they made elegant articles for the toilet as well as cups, vases, and urns. On the walls of the tombs there were sometimes depicted the processes by which pottery was produced, showing in the most simple and perfect way the making of round vessels from the kneading of the clay to the shaping on the wheels and the firing in the ovens. Egyptian beads and dress ornaments were made in pottery, as well as little animals cleverly and grotesquely fashioned and coloured, no doubt for the use of the children as toys. Rings and other personal ornaments of pottery are also found with the mummies.

The ancient Briton made pots which are sometimes

found in the barrows, or grave mounds, about the country. They are mostly either domestic or for funeral purpose to contain the cremated ashes of the dead. In this case, Mr. Charles Binns suggests a very interesting theory, namely, that these vases or urns were burned on the same funeral pyre that consumed the bodies of those undergoing cremation, and then were used to contain the ashes. Be that as it may, we know that the wheel was not used to make this pottery, it had to be built up and squeezed into shape by hand only. It was a matter of patient effort to obtain the regularity of outline that we see in many of these vessels. They were sometimes impressed with cord or leather thongs, which gave an idea of pattern upon them. Later, after the Roman invasion, the influence of the invaders was seen, and the potter's wheel was used on which to make the pots. This ware has been continually discovered in Britain, being generally made of the clay of the district in which it is found. It is mostly of a greyish-brown colour, although some is nearly black, probably caused by the effect of dense smoking during its burning. The shapes were simple and suitable. Fragments of a bright red earthenware, often enriched with simple modelling, are occasionally found on Roman sites such as Wroxeter. Known as Samian ware, it is generally believed to have been made on the Continent.

Greek Pottery. About the wonderful and glorious pottery of Greece volumes have been written. It attained a quality and beauty of form never surpassed. Fine Greek vases were made as early as 400 B.C. in considerable quantities, and are now treasured in practically all important museums. They have been found (mostly within the last 100 years) in the ancient tombs in many parts of Greece, Sicily, and Italy. One would scarcely find it possible to enter exhaustively

into a detailed description of these glorious works of art, but there is no doubt they were designed to fulfil the useful conditions of the everyday life of the period in which they were made. The earliest specimens were made of clay somewhat red in colour and entirely devoid of ornament and, later, finely decorated. Although more precious materials, such as ivory, bronze, silver, and gold, were known and used, it did not always follow that the more precious material was the most highly valued or esteemed. The vessels, whether with or without ornament, were really judged for the quality of their exquisite workmanship, and those described as the Myrrhine vases, about which the late Mr. Solon wrote a most interesting brochure, were the most in demand, and were of the highest value. These wonderful Grecian vases not only were distinguished for their excellent shapes, but were also very wonderful in their decorations. The embellishments were nearly always carried out in the form of bands, although in some cases, being very deep, they nearly covered the whole surface of the vase. Figures were very freely used, and in some of the earliest of the work were painted, on a yellowish-red ground, in black. It is supposed that these decorations were put upon the surface before the vases had been fired, but merely hardened, the black pigment then being absorbed as it was painted upon the ground. It is claimed by some writers that the artist in many cases drew only the outline of the figures, and that the solid interior was filled up by inferior workmen; this, however, is doubtful and, though interesting, does not matter in the least, the final judgment of quality being estimated by merit alone.

In the later and finer period of Greek vases, however, the decorations, mostly figures, appeared upon the vase in red, the background being black. The body of the

vase was in fine red clay upon which the figures were carefully outlined, the entire background was then painted black right up to the outline, and a much higher quality of drawing and definition thus became possible in the figures. The work was done with extraordinary skill and spirit, and depicted in many cases ceremonies and incidents in the lives of the people. Later on, with an unfortunately overdone elaboration, brought about by the demand for more and more luxuriant effects, an artistic deterioration set in, and decline was only too rapid.

Very wonderful statuettes were also modelled in the finest period known as Tanagra, being so called from the place where many of them were found. It will be impossible to over-emphasize the real beauty and charm of these wonderful little figures. Very many of them exist, a fine collection being on view at our own British Museum. They are of immense value, both from the point of view of quality and money, and possibly nothing finer in the way of free and brilliant modelling can be found in pottery than is seen in these little terra-cotta figures. Many imitations are made that do scant justice to the originals, but anyone will be well rewarded indeed by visiting any well-known collection. In addition to the vases and figures of this wonderful period, some of the other articles to be mentioned are the Kylix, or shallow, two-handled drinking cups; the Amphora; and the drinking cups known as Rhytons, on which animal and human heads were finely modelled.

Chinese Pottery. Without making any attempt to deal fully with Chinese porcelain, it is of such undoubted importance in the potter's art that it must receive adequate rather than passing recognition. China is the great home of porcelain, and it is claimed by writers

that the art of the potter was known and practised as early as 2000 B.C. It was in 185 B.C. that porcelain was first invented, in the period of the Han Dynasty. We are more concerned with this porcelain for which the Chinese have been for so many centuries celebrated. It derived its name from the word *porcelaine*, a French term which was in existence long before the introduction of this Chinese ware into Europe. This word was derived from the supposed resemblance of its glazed surface to that of some marine shells known as *porcella* (Italian for little pig).

The Chinese themselves disseminated all sorts of fairy tales as to the composition of the body. It was declared in some cases that it was simply a composition of egg-shells, marine animals, and such other things, and these stories were told amongst children by parents, professing that the mixtures were to be kept secret, the tales being gradually retailed by travellers on their return to Europe. It is certain, however, that for many centuries the composition of the body was kept a profound secret.

The first European who is recorded to have penetrated into the production of the porcelain in China was Marco Polo, a Venetian who, writing in the thirteenth century, alludes to the importance of the manufacture of porcelain in China.

Services of porcelain were sent as presents of great value to the Caliph of Syria, and no doubt later found their way into some of the European Courts. The Italian Medici were known to have received some large vases of Chinese porcelain.

The first real discovery, however, into the secret was made by a French Jesuit missionary, Père D'Entrecolles, who went into China to establish missions about the year 1710. He discovered through communications

with some of his converts, and by continuous and careful research, many particulars respecting the production of porcelain, and was permitted personally to inspect the processes of manufacture. He detailed all these particulars in a letter which he sent to Paris. He also obtained specimens of the materials, and these, together with the information he had gathered, resulted in a series of experiments in France, which are said to have led to the production of the Sèvres porcelain.

The wonderful vases of Chinese manufacture exhibited in many of our museums, and particularly in South Kensington and the British Museum, are excellent examples of fine design in form, and no less remarkable for the wonderful disposition of the ornament upon their surface. The beauty and colour and the fine sense of proportion in many of these designs have never been excelled, and there can be no doubt that some pieces of Chinese porcelain have stood, and will remain, as perfect examples of the potter's art.

The Imperial manufactory described by D'Entrecolles, was situated in the town King-te-Chin, in the midst of a huge plain, and had a population of more than a million souls. It was here that much of the fine Chinese porcelain was made, finding employment for all classes of the population in the different processes of manufacture. The plain was surrounded by high mountains, and the materials for the use of the potters had to be carried a great distance. It is said that about 1790 there were 3,000 furnaces for the baking of the porcelain made in this town, and at night, when these furnaces were alight, the whole sky was illuminated as by a forest fire.

Chinese porcelain contains a considerable quantity of Felspathic rock called Kaolin, and another rock of the same geological origin called Petuntze. Some of the

Chinese porcelain is so extremely thin that it is described as egg-shell, is very translucent, and the shapes are of extreme elegance and beauty. Dr. S. W. Bushell classifies Chinese porcelain under the following periods—

1. The Primitive period included the Sung Dynasty, 960 to 1279, and the Yuan, 1280 to 1367.

2. The Ming period comprising the whole of the Ming Dynasty, 1368 to 1643.

3. Kang-Hsi period extending from the reign of the Ming Dynasty to the close of the Kang-Hsi.

4. Yung-Chang, or Ching-Lung period, 1723 to 1725.

5. The Modern period, from the beginning of the reign of Cha Chaing to the present day.

One of the most highly-esteemed styles of Chinese pottery is what is known as Crackle ; it shows minute crackings, or crazes, over the surface of the ware, and it is claimed that it can be produced with either small or large markings as desired ; into these markings a colour is rubbed and refired, giving an effect of net work over the whole surface.

Another well-known style is the transmutation glazes, embracing different types of Flambé. These wonderful glazes of varying red types, from the deepest blood red to the scarce and highly-esteemed Peach blow, are produced by the effect of reducing atmospheres upon copper stains. Some of the vases known as Peach blow, which is a very delicate pink tint, have realized huge amounts in sale-rooms, but the whole range of Chinese pottery, with all its wonderful variations, must command the admiration of every person interested in ceramics.

There is just one feature, however, that should have been mentioned, namely, the habit of some Chinese potters of putting inscriptions upon their ware, because the same idea was introduced later quite freely into

early English pottery. Some of the inscriptions found upon vases are intensely interesting—

“ Ou, the old man who lives in solitude.”

“ Riches, high rank and much virtue.”

“ Fine vases for the use of rich and noble people.”

“ Fine vases of the Hall of Jade.”

Whether these inscriptions were the result of a commission and added by request or as compliment, of course cannot be known, but they are extremely interesting.

Persian Pottery. We shall only refer briefly to Persian pottery. This beautiful ware is most frequently seen in the form of tiles for the decoration of walls; it is made upon a coarse siliceous body, covered with an engobe, on which in its raw state the patterns are painted. When glazed and baked the colour and the glazes being melted together give an extremely soft yet rich effect. The colours used were mostly turquoise, deep blue, and green, the variation of the colour effects with these agents being very wonderful and beautiful.

Other styles of treatment are carried out in metallic lustres, and the patterns are mostly designed with motifs derived from flowers and foliage, the tulip and the Indian pink very often appearing.

Many fine examples are also to be seen with modelled embossments of horses and riders, gazelles, antelopes, and other graceful animals and birds. Others are found very frequently in the form of dishes for rice, and also in bottles and vases of extremely elegant shape. They copy, more or less, the characteristic forms of metal ware of the same period, and, indeed, are very frequently mounted with brass for use as rosewater sprinklers, the spout, handle, and covers being of metal, no doubt being found more practical for the purpose required, and far less liable to breakage.

The quality of design is of a very high standard, the distribution of ornament invariably being in the best taste.

Porcelain was never made in Persian ware as far as we know, the nearest approach to it being the fine stoneware which had only a slight degree of translucency.

Majolica. An extremely important development in European pottery was that called Majolica. The name was derived from one of the islands in the Mediterranean, where at a very early date such pottery was made, as early as the fifteenth century, and later in many of the large towns in Italy. The body of the ware was somewhat coarse and rude, but was covered with an opaque glaze in which tin oxide was an important ingredient. In combination with lead when melted in the ovens a soft, milky-white glaze was developed. In painting on the raw (i.e. unfired) glaze in bold firm lines, which were slightly softened and spread in firing, a pleasant decorative effect was obtained.

Painting in metallic lustres of richly-glowing tints of gold, ruby, and other colour, was practised with great success by Maestro Giorgio Andreoli, of Gubbio. The designs were bold and free, and in combination with cobalt masses the lustres gave a result of superficial quality impossible to excel.

Many fine pieces of this ware are to be seen at the South Kensington Museum. The vases are of excellent shape, a pilgrim bottle with mask handles of the sixteenth century being specially noticeable for its extreme elegance and balance, a remark that may be applied to many other examples. About the wonderful plateau and plates, too, there is a freedom of design in the patterns that is very marked, and the figure subjects, sometimes derived from contemporary engravings, were

drawn with a firmness of touch and quality of drawing greatly to be admired.

It is interesting in this connection to notice that in Faenza the manufacture of majolica was carried on, and its productions were justly celebrated. It was from this name the term *faïence* was derived, which is still used generally to describe enamelled pottery.

Still another style produced in Italy in this early period was called *Sgraffiato* (scratched or incised ware). The body of the ware was covered with a slip of another colour, the top layer being scratched or cut through to the ground below, this giving a two-coloured effect. This would be glazed and fired, and sometimes afterwards touched up in enamels. It is a distinctly ceramic process, and one still susceptible of considerable development. It will be referred to later on when writing of modern English processes.

Majolica was also made in Spain, and was often confused with the Italian product, having many characteristics in common with it.

Passing from Majolica we come to the *faïence* of France. This, like the former, was covered with an opaque enamel which served to disguise the somewhat poor colour of the body itself. It was upon this ground the coloured decorations were placed. We shall only very briefly touch on individual factories, but must mention the wonderful pottery known as *Henri Deux* ware. This was made in a fine body of creamy white, which required no opaque enamel to disguise or hide its lack of quality; the designs of an extremely delicate character were incised in the body, the scratches or incisions being filled in with coloured paste so finely as to resemble on a casual examination a painted pattern. It was glazed with a transparent glaze. Great care and labour must have been expended in its production,

and very few pieces are known to exist at the present time. It is naturally, therefore, of great value. Tazzas, candlesticks, and ewers were the kind of articles produced.

Let us next mention, possibly, the best known of the great French potters, Bernard Palissy, who was born about 1510. The romantic history of his trials, experiments, and ultimate success, has impressed his name on the memory of most people. His diligence, patience, and tremendous perseverance were, after many years of extreme poverty, rewarded by comparative wealth. The story of how he burned his chairs and tables, and tore up his floorboards to use as fuel for his kilns and ovens, and was finally rewarded by discovering the enamels he required for his wares, has been often told. The museums in most countries contain examples of his work; they are mostly embossed with fishes, shells, animals, or foliage closely copied and coloured from natural objects, although in some pieces, such as a ewer in our own national collection at South Kensington, figures in relief are used. A plateau also showing a figure of Flora finely modelled and surrounded on the rim with embossed ornaments, is evidence of the high quality of his work.

At Nevers, Rouen, Luneville, Marseilles, and other French cities beautiful earthenware was produced.

In Germany, faïence was also extensively manufactured, and in addition stoneware was introduced. This latter was used for many kinds of the rougher domestic utensils for ordinary use, being very strong and vitreous, and capable of withstanding rough usage. It was glazed very thinly by the introduction into the ovens of ordinary salt. Such articles as jars, jugs, pitchers, flagons, and pots decorated with masks and coats of arms were made in large quantities.

Holland was noted for its Delft ware, the famous blue

and white, perhaps the best known of any European pottery. It was established at the town of Delft towards the end of the sixteenth century, and may often be found in old English houses in the form of tiles surrounding fire grates. The ware is of itself a rough texture, but is covered with a tin enamel upon which the designs, mostly in blue, were painted. Chinese motifs were freely used, but the simple methods applied produced a very pleasant decorative effect, other colours, yellow, green, and red-brown also being used in the decorations.

The making of pottery in England is perhaps the most interesting to the average reader, because its development from the earliest times to the present day can be traced in some of our museums. The writer would like to take this opportunity of expressing regret that more museums of this country do not acquire and exhibit representative specimens of our present-day manufacturers. The view appears to be taken that until a pot becomes an antique it is hardly worthy of being publicly exhibited.

Nothing of particular interest was produced in England until soon after 1600, when we got the slip ware of Wrotham, in Kent.

Mr. Solon describes the slip decorated ware very fully in his *Art of the Old English Potter*. Such articles were made as dishes, posset pots, tygs, candlesticks, jugs and, strangest of all, cradles. These latter were no doubt for use at christening functions, possibly filled and emptied in healths to the infant—but anyhow a pretty fancy.

The tygs were embellished with many handles, either for passing round or for decoration. The shapes were good, and the general appearance interesting.

The decoration was done with slip or liquid clay about

the consistency of cream, poured through a tube attached to a small vessel, in the form of running traceries and dots, which stood up from the surface of the ware, boldly and freely decorating the pot. Floral motifs boldly treated owing to the method of application, and dates and inscriptions in bands around the piece, were frequently used. A jug called a puzzle jug was also made here, formed in such a way that to the uninitiated a stream of liquid down their vests was the certain result of using what appeared to be the spout.

It was at this period that the use of inscriptions to which we referred in our previous article on Chinese ware was extensively used in these early English vessels.

These inscriptions are extremely amusing and interesting, such as—

“The best is not too good.”

“Drink for pleasure, repent at leisure.”

It was soon after this that Toft ware was made in Staffordshire at Bradwell Wood, about a mile from Stoke-on-Trent. Large circular dishes were amongst the most striking of the articles made, some being as much as 20 in. in diameter, and lately one of the finest examples was purchased at auction for £1,000, and was presented, together with a fine collection of English pottery, to the museum at Hanley, by Thomas Twyford, Esq. Naturally, considering the way in which the decorations were applied—in the same way as the Wrotham ware—the drawing was not too accurate, but Thomas Toft was an ambitious soul and did not hesitate, with his crude methods, to use the human figure in his choice of subjects. None the less the general effect was really good, and the dishes made imposing ornaments on the oak dresser of the period.

It was soon after this time that the Delft ware, imported from Holland, was copied by the English potters.

Some of it was made at Lambeth, where a Dutchman took out a patent for making pottery after the manner practised in Holland. Much of this ware also bore inscriptions in doggerel verse. Punch bowls and puzzle jugs were favourite pieces.

A most important development was made about this period, 1670, when Dwight, at Fulham, took out his patent for stoneware. It was particularly remarkable for the production of a series of wonderfully modelled figures and busts, one of the latter, a life-size portrait of Prince Rupert, nephew of King Charles I, being perhaps the finest example of stoneware in existence, worthy of any age or any country. The statuettes were mostly portraits, original, and full of quality.

The clay, which was particularly plastic, was very suitable for this class of work, as it was easily manipulated when soft, and would possibly acquire a little extra sharpness in firing as it contracted. This character of plasticity, however, brought about a very considerable contraction, the finished piece being about an eighth less than the original model. At certain periods of baking, common salt was thrown into the ovens through openings high up the sides, when becoming vaporized it combined with the silica on the surface of the clay and formed a glassy surface of great durability.

This stoneware was made also at Nottingham and Brampton. Mr. Blacker has just produced a fine volume on English salt-glaze stoneware, dealing fully with its development from Dwight to the present day.

It was in Staffordshire, however, that the great development in the manufacture of pottery was brought about. It is on record that about 1686 considerable ware was being produced here, principally at Burslem, or Bursley, as Arnold Bennett calls it. The probable reason for the carrying on of the industry in this district

was, of course, the presence of coarse clays of different kinds and colours in combination with the presence of coal, and, although at the present day nearly all the English pottery is made in Staffordshire, the finer clays are imported from other places—china clay from Cornwall, ball clays from the south of England, felspar from Scandinavia.

However, the presence of the natural clays around Burslem created at the end of the seventeenth century an industry for producing domestic articles and such things as butter pots which were very generally used. The ovens for baking them were very small, about 8 ft. by 6 ft. These domestic goods were carried about Staffordshire and the neighbouring counties by "crate men," and gradually were sold all over England. The different coloured clays naturally suggested to the more ambitious potters the mixture or blending of them into pleasant coloured combinations, and this was done by combining the soft clays of different colours together or, as in the agate ware, by wedging together thin slices of the different colours and making still further markings and twistings by pressing and thumbing the soft clays in the moulds. This old ware is, to-day, much sought after, and some of the pieces are of great elegance of form and very thin and delicate. Coloured glazes were sometimes used to heighten still further the colour effect. Later on, glazes alone were used in varying colours, the ware being known as tortoiseshell, which it somewhat resembled.

About this period two brothers of Dutch extraction, named Elers, came to Staffordshire and settled at Burslem. They worked at a farm in Wolstanton, close to Bradwell Wood, and produced pottery made with a fine red clay embossed with sporting and other motives in sprig form. Dimsdale was about a mile away, and

here they stored and sold their ware, and Mr. Solon relates that the two places were connected together by a tube of clay pipes, through which conversations were carried on. Necessity was indeed the mother of invention. Teapots and cream jugs are the articles one most often sees of this ware, and no doubt large quantities of these were in demand as the use of tea was becoming general.

The Elers are said to have introduced salt glazing into Staffordshire, and some writers have suggested that they may have had the advice of Dwight, also a Dutchman in this matter. The work was carried on with the strictest secrecy, but two potters, Astbury and Twyford, employed there, carefully watched the methods and processes, and started manufacturing for themselves. The result of their labour, however, never reached the quality of that of their masters, being coarser and in poorer taste.

The well-known pottery made by Whieldon may also be mentioned, articles such as teapots in the shape of cauliflowers, pineapples, etc., beautifully potted and coloured in a naturalistic way, with the additional use of a copper-green glaze.

The Toby jug was made about this time, and a very jolly and English-looking old gentleman he was, with his jug and his pipe. The lucky possessor of an original one made by Wood, of Burslem, may obtain for it a good round sum.

Mention must here be made of the beautiful salt-glazed white stoneware. The shapes were of great excellence, finely and elaborately modelled; produced from metal or pitcher moulds, they were almost as sharp as the original models, and, being glazed with salt as previously explained, lost none of their quality in the process.

Plain shapes were also made in jugs, teapots, tea caddies, and similar articles, beautifully potted, thin and

elegant. The decorations were sometimes painted in enamels—groups of flowers and Chinese scenes being most usual. The productions of this ware, very fine in colour of body and good potting, marked an important advance in English pottery, and still further enhanced the growing character of Staffordshire ware.

We now arrive at the Wedgwood period of 1730, when the great Josiah was born. At the age of 14 he was bound apprentice. The wonderful work he did for the potter's art has been described frequently and exhaustively by abler pens than ours, but it may certainly be said that Staffordshire, having attained to prominence by the production of salt-glaze, was lifted to the height of her fame by this great potter. His capacity for making fine pots was equalled in a way by his capacity to sell them, and so provide the sinews of war for still greater achievements.

It was in the old town of Burslem that Wedgwood set up his works. The best known of his wares were the basaltes, the jasper, and the Queen's wares, the last being cream colour earthenware, and used for all kinds of domestic purposes. It was with the basalt and jasper, however, that Wedgwood's name was principally associated. The ware was very beautiful in shape, and the embossments and handles in the classic styles were cleverly and delightfully modelled and applied.

Flaxman, as is well known, modelled some of the finest of these reliefs, which were reproduced from pitcher moulds and sprigged upon the turned vases. In the case of the jasper ware the grounds were produced in various colours—blue, black, lilac, and other tints, the ornament or sprigs being mostly in white. An extraordinary degree of skill was shown not only in the designing of these pieces but in the production of them. No glaze was required, as the body was fired at such a

high temperature as to give a hard smooth surface, very pleasant to the touch, and retaining all the sharpness of the original model.

Busts and figures were also produced in the basalts, many by the modeller, Hackwood, which have by age and atmosphere acquired a most pleasant patina, giving an added charm to the excellent modelling.

The Queen's ware, of a rich creamy tint, was named after Queen Charlotte, for whom some of the pottery was made, and this marked a very considerable advance in Staffordshire production.

Josiah Wedgwood suffered under the greatest disabilities with regard to health, but his unshakable courage and perseverance enabled him to carry out such a work for the development of the potter's art as proved to be of the greatest value to his country.

The early and middle part of the eighteenth century saw the fashion for porcelain which had been made in Europe brought to this country, and it was at Bow that the first porcelain was made in England. A considerable industry sprang up here, several hundred people, including a large number of decorators, being employed. The decorations were mostly in the Chinese or Japanese taste. The ware was of a tender and delicate character, and in about the year 1780 the works were purchased by Dewsbury, of Derby, and the moulds and patterns transferred to Derby where they were absorbed.

The Chelsea factory also flourished about this period, and very beautiful porcelain for use as well as figures and ornaments were produced. The ware is distinguished for fine and careful finish, the decorations being tastefully and neatly executed. The figures had a good deal of character, the modelling being clever, and the subjects pleasant and appealing.

These works also were purchased by Dewsbury, of

Derby, thus getting rid of strong competition. He carried on the work at Chelsea for some time, but ultimately, as in the case of Bow, removed the patterns to Derby. Derby thus had practically a monopoly of porcelain in England, and very fine ware was produced there down to the beginning of the next century.

It was in about the year 1750 that Worcester porcelain was invented by Dr. Wall, and here, under varying management, it has been made down to the present day.

Printing, about which we shall have much to say in the pottery processes in this book, was very considerably developed, and engravers were employed in the work.

China painters also, who had found themselves stranded at the closing of the Chelsea factory, found their way to Worcester and produced very charming work there. Amongst the early work of this factory, the scale blue and apple green used for grounds are perhaps the best known types.

In 1788 these works were purchased by Thomas Flight, and he was joined later by Mr. Barr, the ware being known as Flight & Barr. A good many armorial sets were produced about this time by Chamberlain, who was also running a pottery at Worcester, and in 1840 the two potteries amalgamated and became the forerunners of the present firm.

At Plymouth and Bristol and Swansea important factories were also working, and the productions of porcelain by the English factories attained a very high standard of quality, comparing well with the continental products.

NOTE.—Quite a number of publications, issued about the end of the eighteenth century, mention the productions of Benjamin Plant of Lane End, now Longton. His name occurs on pieces in the possession of Mr. John Plant of Salford. Mr. Hailstones had a pair of lions inscribed "Benjamin Plant, Lane End." Other pieces have also been handed down to his direct descendants. The ware was finely potted, some of it being in the form of a stone body, beautifully modelled and embossed, and other pieces in white glaze, similar to the old basket ware. "Lane End" is, of course, part of the now Federated Borough of Stoke-on-Trent, the centre of the industry in England.

CHAPTER II

CHEMISTRY AND POTTERY

WHAT is meant by "Pottery"? The term "pottery" is so wide, and covers such a range of potted articles, that it would be impossible in any one book to deal with the whole subject. Even bricks may be regarded as a form of pottery, and yet the very finest porcelain comes also under the same description. We can therefore only select one or two types to discuss in this short description of a very wonderful industry.

Chemistry plays a very important part in the industry, and perhaps it will be just as well to deal with this side of the question in a special chapter.

The chief characteristics of earthenware are that it is a pottery body made of white materials, mixed in such a proportion that they produce, after the first fire, a hard white opaque ware which is not translucent, and usually not vitreous. When struck it has a ring about it, and in use is durable and fracture resisting. This body has to be covered with a soft vitreous glaze containing lead in some form or other, borax, and other materials described in more detail later on. It has to be fired a second time to melt this glaze; the first fire having been necessary to bake the clay piece and to take out all contraction; the second fire being solely for the purpose of melting the glaze to give it the brilliant gloss. It would be extremely difficult to make good class earthenware with one fire only, although for some articles this is done to-day, the glaze being applied to the clay piece. Of course, if the one-fire process can be adopted it is very much cheaper than the two-fire,

but for reasons of perfection and finish the latter has been generally adopted.

The materials used in the manufacture of pottery may be divided into the following groups—

1. Clay, consisting of ball clay and china clay.
2. China stone of various kinds.
3. Flint.
4. Felspar.
5. Bone, and various colouring agents such as cobalt oxide.

A more detailed account of these materials will be given in a later chapter on "Body Materials." The proportions in which these materials are mixed decide whether the body shall be parian, opaque earthenware, vitreous earthenware, or bone china. Bone china contains a large percentage of ground bone ash with the addition of stone or felspar and china clay. Ball clay is seldom used in the making of china owing to the fact that its colour is not as good as the china clay. China body should be hard, white, practically vitreous, and translucent; should ring hard and true when sounded, and when finished should be free from any dirt or specks, so that when held up to the light you have a pure translucent article. It is so difficult to arrive at this perfection that very few manufacturers attain it. Only the purest materials and the most perfect recipe, with very great care, will result in the ideal china body. It is far more difficult to make really good china, owing to the smallness of margin of error in its manufacture, thus leading to body troubles that are far less liable to occur in the more generous earthenware mixture. China is fired in the clay state first of all to harden the body and to render it translucent. The temperature usually required is about 1,250 degrees centigrade, and owing to this high temperature the loss in making is

proportionally greater than in the easier fired earthenware body. We cannot say that we have ever been able to reach finality in the mixture that may be regarded as ideal for china. Year by year improvements are effected, and there is no doubt about it that in English china we have to-day the finest porcelain body yet produced. When building up a recipe for either china or earthenware several important things have to be borne in mind. First of all, the body must be plastic enough to be easily workable into the various shapes required. It must be infusible enough to prevent collapse during the biscuit or glost fire, and in addition to whiteness must not have too much contraction, or the loss in the ovens, due to crookedness, would be far too excessive for it to be a commercial proposition. The body must be free from iron and dirt, or colouring matter of any description. Otherwise, the necessary purity would be destroyed.

It is possible to specify many other requirements desirable in the ideal china or earthenware body, but the above list will probably do to show some of the main qualities necessary. Stone by itself, clay by itself, or bone by itself would not enable us to attain the result required, so that it has been found necessary to mix various materials in certain given proportions before a suitable body can be produced. The glaze is used in order to cover the biscuit piece with a transparent shell in such a way that it renders it impervious to moisture or dirt. The glaze must have good covering or flowing properties. It must be translucent. If underglaze colours are printed on the biscuit ware, the glaze must be so balanced as not to destroy or injure them. It must fit the body exactly, that is, the coefficient of expansion between body and glaze must be exactly the same. If this is not so we get crazing or

peeling, and, as sometimes this crazing does not develop until the ware is actually sold and in use, it is a matter of prime importance that a very careful test should be applied before it is put on the market.

Chemistry and Pottery. As already mentioned, chemistry plays a very large part in the production of all types of pottery ware. In the old days it was largely a matter of practical experience that enabled the potters to evolve gradually, after very long and laborious experiments, the early porcelain and earthenware bodies. Many of these bodies, as samples in our various museums show, were far from being perfect. The same criticisms would apply equally to the glaze, which was often dull, full of pinholes, and without that brilliant surface which distinguishes modern pottery. The application of chemistry to any large extent in the pottery trade has been due undoubtedly, in our own country, to the foundation of the English Ceramic Society, and the ultimate founding of the Central Pottery School of Science, which is erected and maintained in the seat of the industry.

It was once a very difficult matter to put things right with body or glaze when for some unknown reason they went wrong. The writers know of a case where a business was almost rendered bankrupt by the continuance of a fault in china which to-day is sometimes called "rinderpest," but is really a change of colour from white to brown, and shades of green and pink, in the finished article during the final fire. The Ceramic Society tackled this disease, for it was at one time very prevalent in the china industry, and found that it was due to the stone in the body lacking the necessary vitrosity. What actually takes place is rather difficult to explain, but the lack of flux in the body mixture readily upset the narrow margin already referred to,

and hence followed disaster after disaster. This fault to-day has been traced and the remedy applied with most satisfactory results throughout the trade. It has been a fact that, in the past, many pottery glazes as well as bodies, built up on rule of thumb principles, have lacked that stability and freedom from fault which is essential. A simple illustration of this is to be found in the fact that so much common earthenware, even to-day, such as pudding bowls, bakers, and similar cooking utensils, often craze after being in use for a short period. This, of course, is fatal, and certainly very dangerous from a health standpoint, due to the fact that the earthenware body, being more or less porous, takes up a certain amount of the food cooked in it. Gradually this decomposes, and as a crazed article is used over again for cooking purposes these impure gases are released. It ought to be unnecessary to urge upon anyone that the use of crazed ware, or ware with the glaze chipped off the edges, etc., if it be of a porous nature is unwise, to say the least of it. Even English bone china is slightly porous, but modern investigation is proving that it is possible to have a bone china body so nearly vitreous that it can be said to be as safe in use, even though chipped, as any glassy porcelain.

Chemical knowledge is of great use to a potter in all the various processes. It not only controls the mixture, the colours, the glaze, but, if his results are to be standardized, it must control the purity and quality as well as the analysis of the materials he uses. Chemistry by itself would hardly succeed in producing perfect pottery. There must be along with it a fund of practical knowledge which can control any chemical data, and use it in combination with proved facts obtained by experience. A knowledge of chemistry will readily teach the potter that certain effects are obtained in

certain ways. A reducing fire will change certain colours, and glaze that crazes can be improved by the addition or extraction of certain materials. Practical knowledge may also prove these points, but, where practical knowledge may be labouring alone for a period of months, chemistry steps in and is able to suggest to the enquiring mind the probable cause of a defect that more often than not proves to be correct. The wonderful colours produced to-day in the English pottery trade, both in high-class china and in the wonderful transfers used in the earthenware trade, could never have been produced without the knowledge of colours combined with chemistry. It is impossible to draw a line where practical experience finishes and where chemistry begins. The chemist might very easily give a recipe that would produce a beautiful white piece of china, but such recipe might be impracticable from a potting standpoint. Here practical experience would be able so to control the original suggestion as to bring about the result desired. The practical potter is the best man to decide in what physical condition to use his materials. He would, for instance, know that to avoid certain faults, and to assist the plasticity of the body, the bone, when weighed in for the body mixture, must always contain a certain amount of original moisture. He knows that stone should never be burnt on the drying kiln ; that felspar, after grinding, is best run direct on to the drying kiln, and not stored in the slop state in an ark, owing to the fact that it is liable to set so rapidly that it would have to be dug out with a shovel. There is no doubt also that pan ground materials, although they may be of the same chemical composition, are more plastic and easier to use for the potter than the same materials ground on the cylinder. This is entirely due to a physical cause,

and is not a matter that is controlled by chemistry. Thus we have side by side the practical and the scientific. Both are necessary, and more than ever to-day the scientist is proving to be the true friend of the potter. Can anyone say that finality has been reached in pottery bodies, both bone china and earthenware, and other classes? It may be possible, and we believe it is, to make a china body that will be absolutely fracture-resisting; to make an earthenware body that will cost no more and yet be stronger and far more durable than the general type of earthenware made to-day; to make a glaze that will not craze, spit out, blister, or peel under any conditions; so to control this latter article that it will dip easier, and during the fire flow evenly over the pottery it is applied to. Ordinary practical experience may enable a potter to arrive at the ideal somehow or some day, but, generally speaking, the application of chemistry, sensibly applied to problems such as those suggested, will inevitably result in quicker progress. Chemical knowledge enables one to build on a sure foundation, step by step, thus judging cause and effect as applied to the problem in hand, whereas ordinary practical knowledge may be placed at great disadvantage at any point by a defect that it is almost impossible to overcome without that little extra which science gives. For the colour maker, chemistry is absolutely essential. The rule of thumb method may enable a man to produce what is apparently a beautiful black, but potters have had very unhappy experiences with some of these colours, which, owing to a fault in the formula, has proved to be, when actually applied to the ware, more of a snare and a delusion. How many buyers of pottery have had to complain to their suppliers about black handles oxidizing as they stand on the shelves; blue band chipping and oxidizing, and many other colours

changing even before passing into the hands of the users? A ceramic chemist would be able to judge from the recipe almost at a glance whether these colours were permanent or likely to cause trouble in the future, and no potter wishes to sell anything that will give rise to complaint. Hence, the growing need for all our recipes to be so compounded and standardized that these troubles may be avoided. The chemist in the pottery trade has come to stay, and every year will be regarded as more of a necessity instead of as in the past being looked upon as a luxury.

THE WINNING OF POTTING MATERIALS

China Clay (or Kaolin). China clay is generally recognized by high authorities on Geology as being derived from the natural decomposition of granite, and it is amidst the granite masses of Devon and Cornwall (more especially the latter county) that china clay deposits are found, in larger beds and of finer quality than anywhere else in the world. China clay exists in small quantities in other countries, but Devon and Cornwall alone supply those high-grade china clays which are indispensable to manufacturers of high-class wares, etc.

China clays are classed under two headings, viz., the Sedentary and the Sedimentary deposits.

The sedentary deposits are those which, from time immemorial, have undergone the process of decomposition, and to-day are discovered on the hills of Devon and Cornwall. It will thus be gathered that the china clay most suitable to the pottery manufacture are those produced on the hills amidst the granite masses; the clays being of a hard nature, their production is more difficult and expensive than those produced from sedimentary or valley deposits.

The sedimentary deposits are those decomposed granite particles which have been washed from the sedentary deposits in past ages, during heavy floods and torrential rains, to the valleys below, and, being of a lighter and more friable nature, are generally known as Moorland clays, and are used for loading purposes by manufacturers of paper, linoleum, etc.

Winning of China Clay. The outcrop of a district is a guide to the prospector for china clay, but to ascertain definitely the extent and quality of a china clay bed inspection pits are sunk over a given area before the process of mining is proceeded with. Samples are taken from the inspection pits and submitted for analysis, and should these be free from oxide of iron and in every way suitable for the pottery manufacturer, the removal of the soil, subsoil and rock (overburden), is begun with a view to uncovering the bed of china clay. The most plastic clays are as a rule obtained from underneath a heavy granite overburden.

The necessary pumping plant, whether of the old Cornish or the modern centrifugal type, is being prepared during the preliminary stages, in readiness to deal with the clay when produced.

An ample supply of water is absolutely essential, as this plays one of the most important parts in the production of china clay.

The Cornish steam pumping plant requires a shaft to be sunk to a given depth, a level driven and a "rise" made up through the clay bed. When this is completed the clay deposit is broken by men with picks or "dubbers," water is then allowed to run on the broken mass, or played on the clay through hoses which may be high pressure up to 150 lbs. to the square inch at the nozzle. This stream washes the free clay down into pits, called sand or settling pits, where the coarse

material is deposited. The finer material, still in suspension, flows into the launder, which is a shaft lined with wood. This shaft has holes filled up by plugs, the topmost hole being uncovered to allow the clay in suspension to flow into it. The shaft is connected with the drift already referred to, and from thence only the finer particles flow into the sump in the level.

From this point it is pumped to the surface, whence it undergoes refinement through a series of micas. The

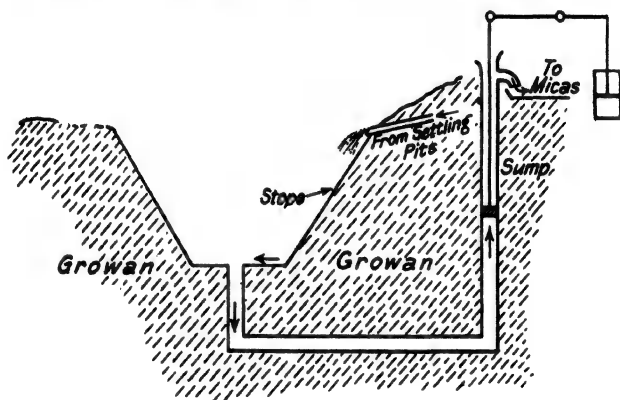


FIG. 1

CHINA CLAY PIT

micas consist of a number of channels of timber or cement construction through which the clay water flows. The wider the micas in comparison to the rate of flow, the slower and better the filtration. These micas may be hundreds of feet in length, and are quite shallow with a very small fall, it being obvious that, should the clay water be allowed to rush through the micas without any check, the impurities would be carried with the clay to the settling pits, and render the

clay practically useless for potting purposes. The stream is therefore also regulated by traps or sills to prevent the deposited particles from being carried forward. The water contained in the pure clay now runs into the settling pits, cement-lined and circular, measuring some 20 ft. in diameter, and 8 ft. to 10 ft. deep.

The proper refinement of the china clay is of the utmost importance, for the reason that impurities such as mica, etc., which has no contraction, would, in addition to lowering the colour of the fired clay, reduce contraction, and render ware manufactured from the clay liable to crazing. As the settling pits are filled, the clay is run through pipe lines to the storage tanks built immediately adjacent and parallel to the drying pan, where it remains until of a sufficient consistency to warrant its being economically dry on the pan.

Modern drying kilns are about 250 ft. to 300 ft. in length, and the pan 15 ft. to 18 ft. in width, usually with six or seven storage tanks behind with a capacity of 300 to 600 tons each. The actual drying pan is composed of fireclay tiles 16 in. by 12 in. laid on the brickwork of the flues. The heat is generated by coal fuel in furnaces at the front of the kiln, the heat being regulated by damper-doors of iron at the stack end of the kiln. The clay when dried is thrown from the pan into the storage room or linhay, which runs the whole length of the pan. From this storage room the clay is loaded direct into rail trucks or wagons, according to whether the linhay is served with a rail siding or not.

Drying. Great care is necessary in the drying of clay, especially at the fire end of the kiln. A too fierce heat would burn the clay, thus destroying plasticity and causing the clay to froth and boil when mixed in the sliphouse.

Cornish China Stone. Cornish china stone, which is found in the St. Stephen's and St. Denis districts of the St. Austell Granite Mass, is the only china stone which contains the necessary properties essential for the manufacture of the finest porcelain and pottery.

The peculiar characteristics of Cornish china stone are unrivalled in the whole world. Japan, France, Saxony, and other countries produce china stone which the uninitiated are apt to confuse with Cornish china stone, but they really bear very little resemblance, neither have they the essential properties found in Cornish china stone.

The several qualities of Cornish china stone are recognized under the following headings—

1. **HARD PURPLE**, a hard white rock with a purple tinge caused by the presence of purple fluor spar.
2. **MILD PURPLE**, a similar rock but softer.
3. **DRY-WHITE OR SOFT**, a soft white variety.
4. **BUFF STONE**, similar to the white, but slightly tinged with yellow.

These grades of stone are sorted out in the quarry as the stone is quarried, and kept ready for shipment.

The winning of china stone is not so complicated as that of china clay, inasmuch as, after the overburden is removed from the stone, the stone is drilled either by hand-drills or compressed air-drills, and then blasted. After the surface of the stone is scraped and cleaned of all vegetable matter, it is broken into convenient sizes for loading on to road wagons or railway trucks, and either sent direct to the potteries by rail or loaded into vessels at one of the Cornish ports.

Great care is exercised by the producers in selecting the stone, and a sharp look-out is made for what is

known in the industry as "shell" (a grey substance) which, if not removed from the stone, would cause blistering to take place in the pottery manufacturer's products.

The following is a typical analysis of Cornish china stone—

	<i>Hard Purple</i>	<i>Mild Purple.</i>	<i>White Stone.</i>	<i>Buff.</i>
Aluminic Oxide	7.51	6.15	18.13	10.17
Ferric, etc. "	2.16	1.85	0.78	1.57
Calcic "	.96	0.82	0.90	1.36
Magnesian "	1.33	1.13	0.63	1.26
Alkalies	2.09	1.25	2.38	2.90
Silica	85.64	88.56	73.72	82.56
Moisture	0.31	0.24	3.46	0.18
	100.00	100.00	100.00	100.00

Ball Clay. The clay deposits of Devonshire round about Bovey Tracey and Kingsteinton in South Devon supply the ball clay used in the pottery trade. This clay has probably been washed down in a way similar to that carried out by the china clay mines of Cornwall, except that in this case the washing has been by natural agencies, and the material has been washed from the granite mass at Dartmoor. It may be assumed that the district where the clay deposit is found in South Devon was at some period a large lake into which ran rivers draining Dartmoor. The sediment carried down by the rivers would be deposited in the still waters of the lake, the heavier and coarser portions first and the fine clayey material in the remoter parts of this great natural settling tank. In addition to the products of decomposition of the granite rocks, there would be associated varying quantities of organic matter originating from the vegetable remains brought down by the streams into the lake. These remains have given rise to quantities of lignite, which are found accompanying

the clay. This lignite is in some cases in lumps of considerable size, in others it is very finely divided, and cannot be removed from the clay even by passing it through a very fine sieve. The lignite is very evenly divided through the mass of the clay in these instances, and imparts a decided black colour to the material. Hence the term "black clay" by which some of these clays are known. The beds are some 70 ft. thick. The lowest beds are sandy, and below these there is no workable clay. The upper beds comprise stoneware clays, open and close in texture. These are mined and exported to the Scotch factories for the manufacture of stoneware. The potters' clays occur between, and are usually black by reason of the lignite. Some, however, are decidedly blue in colour. The clay beds are lenticular in shape, and taper out in all directions, and are very subject to variation in composition and character.

The mining is carried out in two ways—(1) in open pits, (2) by means of a shaft.

The open pit is about 20 ft. square and is cut through the clay, which is removed in square blocks of about 8 in. size, weighing 70 to the ton.

In the case of mining by a shaft, the shaft is sunk some 70 ft. Levels are then driven right and left for some distance. From the ends of these levels drifts are made along the clay body at right angles to the levels, and on the same side of them. These drifts approach each other as they proceed until they meet. The ventilation of the levels and drifts is sometimes natural, but in others there are electric fans which give a good supply of fresh air to the miners.

In the case of the clays containing coarse lignite, it is necessary to look them over to pick out the greater part of this substance. This sorting is done either at the mine or at the wharf before shipment.

The port of shipment of the South Devon clay is Teignmouth, to which place the clay is conveyed either by carts or rail.

Teignmouth clays have a great reputation as potting clays, for, though they may not be quite as plastic as some other clays, they are generally of a better colour when fired.

[Extract from *Visit to the Clay Deposits of Cornwall and Devon*, by W. Jackson, A.R.C.S., and A. G. Richardson. Transactions of the English Ceramic Society, 1903-4.]

Milling of Materials. The preceding chapter has shown the source of some of the more important "body" materials, and now we come to the factory itself, and the preparation of such materials for use. Here, indeed, commences that series of mysteries and processes sometimes called "The Potter's Art."

A successful potter must have many varied qualities—love for his art, powers of application and observation above the ordinary, analytical faculties, a knowledge of shape and design, and at the same time he must be a leader of men, and a seller of goods. Many of the hundreds of faults that occur in the finished or unfinished pot have their origin in the mill, and thus it follows that the potter here must be master of his fate.

The accumulated knowledge and close application of generations of potters have not enabled any of us to say "This is final," and always there is the element of surprise and the unexpected which so often happens, as well as the joy and reward of the object attained.

A short description of a modern mill may not be out of place. A pan mill is generally regarded as the most satisfactory for all-round work. This mill is in the form of a series of round vats, paved with special stone, obtained from Derbyshire and Welsh quarries. Each

of these pavers, measuring from 10 in. to 16 in. square, is so placed as to form a more or less flat bottom. On this bottom the grinding of materials takes place. This is done by the very simple method of forcing great blocks of chert stone over the materials to be ground by means of strong wooden arms bolted to a central revolving shaft, thus adopting to some extent the old windmill method of grinding corn, but with the addition of water to facilitate the grinding, and to prevent dust. The grinding usually takes about 8 to 15 hours, and the materials gradually become something similar to a creamy paste. Alsing cylinders are also used largely for grinding potters' materials, and up to a point they are very economical and efficient.

It is not proposed to deal with all the materials ground at our mills in the potteries, but only those that are used in the greatest bulk, and come to us more or less in a raw state. In the preparation of these materials for potters' use, cleanliness, cleanliness, and cleanliness again, is of the utmost importance. Iron and dirt combined have always been a source of trouble, and only vigilance and care will enable us to keep these enemies at bay. The use of oak for building the vats, etc., wherever possible, and the application of the paint brush at regular intervals will certainly help, but these preliminary precautions are only adjuncts to the use of magnets, the picking over of some materials by hand, sifting, and the personal element of care, which can alone ensure success.

Flints. Flints are so hard that it would be a most difficult matter to crush them in the raw state, and indeed it is only after calcination that they become the white material which forms such a fine frame work round which the clays and stone combine themselves in the earthenware body. It is necessary to see that the

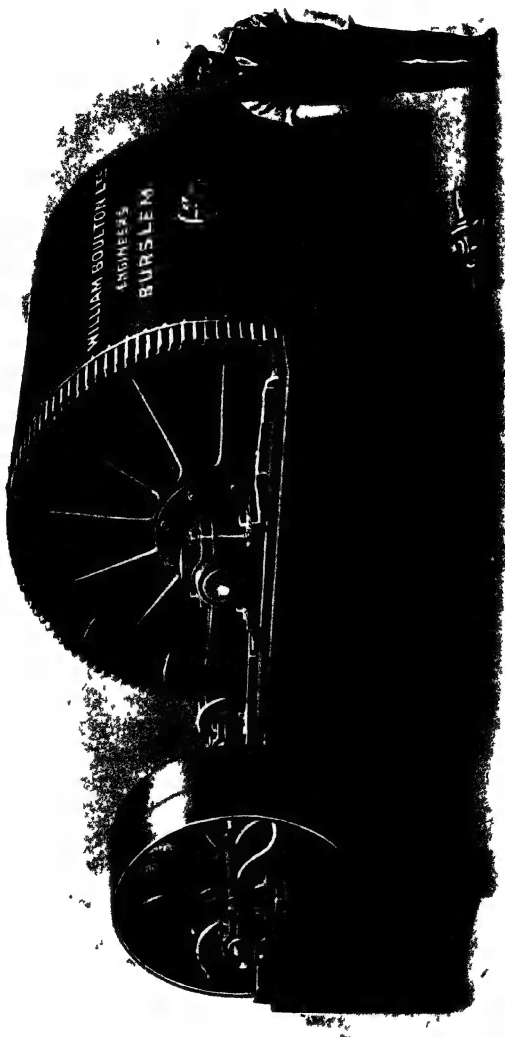


FIG 2
VISING CYLINDER

raw article is clean before putting into the calcining kiln, and that the proportion of slack and flints is regulated so as to produce perfect calcination. This takes 48 to 60 hours. If flint is over-calcined it blisters, and if undercalcined it is difficult to grind. The best flints do not fly and shatter during calcination. After this process the flints are usually crushed in a steel-jawed stone crusher, which reduces them to a suitable size for charging on to the pan. In the case of cylinder ground materials, the size must be much smaller than is necessary for pan grinding. The flint should be mixed with water, and becomes a white liquid after 11 or 12 hours grinding. A grey shade is not usually dangerous, but any pink tint should be looked upon with suspicion. It is then run into the washing tanks, which have the effect of stirring up the fine particles in suspension, and allowing the unground particles to settle at the bottom. Plugs are arranged in the side of the washing tank at various depths, and the plugs are drawn when the rough material has sunk below their level. The finely ground material is run off into arks, and from thence to barrels or direct on to the drying kiln. If the flint is sent out in the slop state it is better to store it in agitated arks, as it has a tendency to settle unless this is done. Care should be taken that the runners in the mill do not always run in the same circle, or they will work grooves in the lower stones, and when new runners are introduced they will not work into the grooves, and the result will be imperfect grinding. Great care should be taken in the selection of mill stones, which must have neither colouring matter nor an excess of lime in them. The mill must not be charged too heavily at first starting, nor should it be driven too fast, or the material will not go under the stones, but be carried round them, or forced outside the slug iron. Only the

water absolutely necessary for grinding should be used, as an excess will tend to increase the time of grinding. Fineness can be tested by trying it between the teeth or nails, but the silk or wire lawn is always the best. Blue Welsh pavers and best Derbyshire chert runners provide the ideal grinding surface for flint and stone.

China Stone. The principal varieties of china stone have been already mentioned: they possess varying qualities, and differ considerably in their degree of fusibility, so that one sample will melt much more easily than another, or in the potter's language is "softer." From a potter's standpoint great importance should be attached to the selection of suitable qualities of stone for the purpose in view, and care should be exercised in the mixing, so that a standard article, having the same degree of fusibility, may be relied upon from time to time. Stone is not calcined, but is broken up, if necessary, into sizes suitable for crushing, and after this it is charged direct on to the grinding pan, and, if conditions are right, 11 to 18 hours are necessary for producing a perfectly ground article. In this case again, careful washing, to separate the rougher particles, is essential, and in addition to this, if the material is supplied in the slop state, ageing in the arks is usually adopted in order to obtain the correct weight to the pint demanded by manufacturers. A certain quantity of stone comes from Jersey, which is very fusible, and because of its slight pinkish tinge, which is supposed to betray the presence of iron, its value has not been fully appreciated. We suggest that it would be extremely useful in the manufacture of glazes. A most important point, from a potter's standpoint, is the careful selection of the stone used for any particular type of pottery, so that it should be standardized as regards

its fusibility. In the case of dried stone it should never be burnt or over-dried on the kilns.

Bone Ash, as used in the china body, probably demands more care than any of the milled materials. It seems strange to think that our fine translucent English china owes its almost transparent quality largely to the bone it contains, and that without it the result would take us back to an article similar to the products of the mid-eighteenth century. The bone is collected from many sources, the poorer varieties coming from South American saladeros, whilst the finest qualities are collected in our own country. It might be observed here that only bones from cloven-footed animals are considered suitable for the making of china. It would not seem possible for bone to vary much in quality, but there are more kinds than months in the year. Some of these kinds are useless for pottery purposes. Freeing the bone from glutinous matter is a business in itself, and this is usually done before delivery at the potter's mill. South American bones are calcined before shipment, in great piles mixed with wood and other fuel, and one not unfrequently finds among the calcined residue horseshoes, nails, pieces of brick, sand, and other matter which make its use a very hazardous proposition. Even the English bone is rarely free from impurities, particularly iron, and powerful electro magnets are used for the extraction of this. All bone has to be calcined before grinding to burn out the animal fats and to render it friable. The chief difficulty a manufacturer has to face here is the overpowering smell of burning bone, and in the centre of a densely populated area it would be impossible to undertake calcination unless some preventive means could be adopted. Like most problems, the remedy was found to be fairly simple. A bottle-shaped kiln, similar to the flint calcining kiln,

already described, is used, and it is so arranged that the fumes from the burning bone pass through a secondary fire, which has the effect of removing the objectionable smell entirely. The greatest care is now necessary, and by hand picking, and magnetting with high-power electro-magnets, the bone is cleansed and prepared for the grinding process. It usually takes about 10 hours for the efficient grinding of a charge. Careful washing, to separate out the coarser particles is as necessary in bone as in the other materials discussed, and a most important point, which should not be overlooked, is the ageing of this material, which should always be kept in storage arks as long as possible before being pumped on to the drying kilns. Equally important is the final process, for bone must always be slowly and carefully dried. If burnt or over-dried it loses some of its plastic qualities, and leads to increased loss in the manufactured article.

Felspar. This article is of very great value to potters, and is used for many purposes. It is obtained principally from Norway and Sweden. Both in body and glaze its value is appreciated by the scientific potter. It needs careful treatment on the lines indicated for stone, but generally should be washed carefully before crushing and grinding. Usually it takes longer to grind than stone, and owing to its quick setting properties should be run straight on to the drying kiln.

Glaze. The standard rule of testing before use should always be applied to glaze. In no other material ground by millers is the carrying out of this rule more essential. It might not be out of place here to explain that the glaze we call "leadless," or "raw lead," or "lead silicate" glaze is prepared in a similar manner, and becomes, when fired, the glassy covering which renders our ceramic products so useful in the home.

Many materials are used in the production of glaze. First of all the fritt is made. This usually consists of a mixture of flint, felspar, china clay, whiting, Cornish stone, borax and in a few cases small proportions of strong alkalies are added. The object of fritting is to render the soluble materials insoluble in water, for, if mixed in the unfritted state, excess water could not be taken away from the ground glaze, and in addition concentration of the soluble materials is liable to occur at various points during the drying. The mixture is charged on to a fireclay kiln called the "fritt kiln," and, by means of a gas producer or ordinary fire, a very high temperature is applied which soon brings it to the melting point. After about 3½ to 4 hours' "fritting," a temporary block is removed from an opening in the side of the kiln, and the liquid mass, which looks very much like melting glass, or melting iron, runs into a brick tank about 6 ft. deep, half filled with water. The water is used in order to break up the mass and to save the necessity of crushing before charging on to the grinding pan. The glaze, as charged on to the pan, is usually a mixture of fritt with softer added materials and white lead, either in its fritted or raw state. Where the mill is not the private property of the manufacturer, very great care is needed so that the glaze mixture may not be rendered more or less fusible by the charge previously ground on the pan. Sometimes a leadless glaze mixture has been so charged that it followed a rich lead mixture, and the result has been disastrous from the manufacturer's standpoint. It seems, therefore, that one type of glaze should always follow a mixture of the same type. That is, if a glaze is leadless, it should be ground on a leadless glaze pan, or on a pan used only for this purpose. It is almost impossible to clear the pan, after the grinding

has finished, so as to avoid any chance of affecting the next charge. Again, at some mills it is customary to grind parian body and glaze on the same pan, and we have known cases where parian body has been mistakenly used for dipping purposes, with tragic results. Glaze should be well ground—sufficiently fine to pass through at least a 130s lawn—then thoroughly magnetted and kept in storage arks as long as possible to allow it to age. A simple method which can be relied upon to test the fineness of grinding is to dip the hand in water and then coat the thumb nail by dipping into the glaze, blow the surplus off, and rub over with the tip of the finger. Another is the same test between the teeth, as used for flint. If any coarseness of grain is apparent it is almost certain that the glaze is not ready to leave the pan. Ageing of glaze is essential for the best results. It will always dip easier and go farther than new glaze. Thus, neglect on this point means consequent loss to the manufacturer.

Parian Grinding. We may refer here again to the grinding of the parian body, which follows the same treatment very largely as is given to the glaze, and to which most of the foregoing remarks would apply equally. It is easy to spoil materials by overgrinding, and it is just as easy to spoil them by undergrinding. Other faults in the ground material may be caused by using the wrong type of runners or pavers, by iron particles from the slug iron and collar, or by impure water. The miller holds a position that is no sinecure—he must have the necessary knowledge, and must see that those he employs act up to it—the easy way is often the wrong way.

The Drying Kiln. Materials used by potters, for either china or earthenware, have sometimes to be dried after grinding, and for this purpose a long flat floor is

built of fireclay slabs, varying in size from 10 ft. or 12 ft. in width and 20 ft. to 100 ft. in length. The sides and ends are also formed by fireclay slabs, forming a boundary wall about 12 in. high. Under the floor a series of flues convey the heat from a fireplace built at one end, and, as usually the kiln is erected in close proximity to a chimney, the necessary pull is provided to cause the heat to travel under the whole of the kiln bottom. Some materials can be dried quickly, but generally great care has to be taken to see that the heat is not too great, for if the material is burnt it will result in unnecessary and avoidable manufacturing losses. It may take a week to dry a given material, but whether the time is long or short the process is much the same. As the material stiffens through the evaporation of its moisture, it is cut into squares of a foot or thereabouts with a long rod having a right-angle bend at one end, which acts as the cutter. This marking or cutting causes the drying material to split up into square pieces, and these pieces are finally removed from the kiln to a storage bin, and are now ready for use. Cleanliness and care are all important in this process of a very complicated industry.

CHAPTER III

MIXING

The Slip House. Practically all the milled materials are magnetted, more or less efficiently, before being added to the body mixture. In the case of earthenware bodies the materials are mixed in the slop state, so many inches at a given weight to the pint, but usually china materials are dried previous to being weighed.

What part do these materials take in the building up of the body? Probably the word "body" will convey some idea of the relationship to the human body. Certainly the analogy is a close one. In the case of bone china, the bone acts as a skeleton round which the clay and stone wrap themselves. During the making, the clay is the plastic material which enables the body to be handled successfully, and, in the firing, the stone, being fusible, acts as the medium which binds the other materials together, and with bone gives them life and translucency.

An earthenware body—

Should be sufficiently plastic to mould readily.

Should dry and fire successfully.

Should be of good colour.

Should glaze without crazing or peeling.

Should be strong enough to stand wear and tear.

The materials used in compounding it are—

Ball clay.

China clay.

Flint.

China stone.

We may regard ball clay as the base on account of

its plasticity, but this requires correction for colour, drying, firing, and glazing properties. An addition of flint improves the colour, corrects the crazing, and enables it to dry and fire successfully, but to add sufficient to make the colour satisfactory would probably cause the glaze to peel. An addition of china clay improves the colour and makes it possible to introduce sufficient flint to make the colour satisfactory, without risk of the glaze's peeling. An addition of china stone binds the other ingredients together, corrects excessive porosity, and gives strength and durability. By the use of different clays and by variation in the proportions of the other materials, different degrees of colour and hardness may be obtained. For the production of white earthenware a small addition of Cobalt stain is necessary, to neutralize the slightly yellow tint of the body mixture.

Some idea may be gleaned of the difficulty of the task, when one realizes the fact that it is almost impossible to standardize many of the materials used. Bone varies in fusibility ; clay in its composition ; and stone being a natural rock is most liable to change ; hence, we have the constant element of risk and impossibility of taking anything for granted. Fifty per cent of commercial bone in a mixing may give you an entirely different percentage of phosphates one week as compared to the next, owing to variations in the composition of the said bone. Stone may vary many degrees in its fusibility, and only by constant testing of the materials in use can these variations be checked.

It has been said by an eminent scientist that scientifically it is impossible to manufacture bone china commercially. The margin of error is so small, and yet we have this apparent impossibility controverted by the wonderfully successful results obtained by English potters.

Bone china is a much more expensive production than earthenware. First, owing to the high cost of bone ; second, the shortness and difficulty of working the body ; third, the higher temperature at which it is fired in the ovens, and the greatly increased loss in saggars and ware caused thereby.

We have devoted the preceding pages to the preparation of materials, and to a general discussion of them, their properties and use. After this necessary preparation the mixing for the body takes place in the slip house.

In a modern earthenware factory each material is blunged separately, and from the blunger runs into an ark built to an exact size. When this ark is filled to a given point with slip of correct weight to the pint, it holds just the quantity for the body mixing. There may thus be an ark for china clay, an ark for ball clay, another for flint, and another for stone. The weights of each have to be checked very carefully before mixing together to make the final body. Sometimes this process is carried out by a measuring stick, marked in inches, so that the resultant body recipe will consist of so many inches of one material to a given weight the pint, so many inches of another, and so on ; all these materials being finally collected together, blunged, sifted, and made into clay. In the case of china, the stone, bone, and clay are usually weighed in the dry state, and blunged or mixed together in a large tank, having a central shaft, to which are attached knives capable of mixing up the various materials (Fig. 3). The mixture is now in liquid form, and, far from being pure, it has therefore to be sent on to the sifters, which allow the clay to pass through very finely woven phosphor-bronze lawns.

Sifters. A brief description of the sifters may not be out of place. There are many types of these, all

of which are designed to remove any rough unground particles from the slip, and generally to purify it. Sometimes the sieves are three-deckers, arranged in

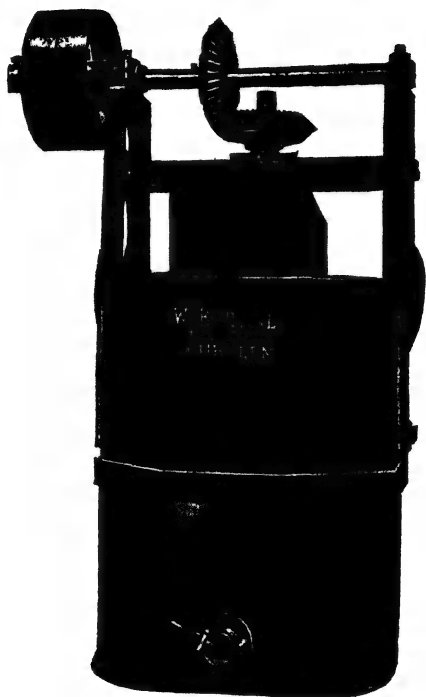


FIG. 3

CLAY BLUNGER

tiers, one over the other. The top sieve may be made of silk or brass, 100 meshes to the inch, the second 120, and the third and final sieve 130 or even 160. The slip is pumped from the ark, and the delivery pipe arranged so as to feed the liquid clay into a suitable



FIG 4
CI W PRESS

tank situated at the top of the sifters. This tank is fitted with an overflow, which returns any surplus to the rough ark, also with a block to regulate the supply to the sifters. The sieves are set in motion, and caused to move backwards and forwards with a shaking movement, by an eccentric drive which operates an arm or rocker clamped on to the end of each sieve. Another type of sieve consists of an oblong box, 5 ft. in length, and having 15 in. sides which are fitted with lawns, stretched on suitable frames and held in place by the necessary bolts. It is open at the delivery end, and closed at the other by a strong wood and iron framework, on to which is bolted a plate carrying the shaft and fast and loose pulleys. The whole sieve is then supported by this shaft, which revolves in two machined bearings supported by suitable pedestals. It is contained in a wooden case having a sloping bottom. This case prevents any spattles from the sieve, as it rotates, from being flung about the room, and causes the sifted clay from the first sieve to pass through the second, and finally to the magnets and fine ark. It has been found inadvisable to use one sieve alone, so the final arrangement has resulted in a combination of two sieves, one above the other, each sieve more or less a unit by itself. A good point about the sieve is that it automatically delivers all refuse into a separate box at the open end, and thus tends to keep itself clean.

Powerful electro-magnets are so arranged that the slip, after passing through the sifters, runs over these magnets, and is thus freed from any particles of iron which may have escaped in the previous processes. After the final magnetting the slip is collected in an agitated ark, known as the fine ark. It is in far too liquid a form to be of use in the making of many articles of pottery; the water, therefore, has to be extracted so as to



FIG. 5
CLAY CARRIER

leave the clay in the necessary plastic condition. In the old days the method of doing this was to run the slip on to a drying kiln, similar to the one already described for drying milled materials. This method is still practised, but is the exception rather than the rule, and has given place to the modern clay press, consisting of a series of wooden trays, built of some hard wood. Each tray measures about 2 ft. by 6 ft. by 3 in. to 4 in. The inside of the tray consists of grooved blocks, each groove being about $\frac{1}{4}$ in. deep. A press may consist of anything up to 36, or even more, of these trays, and between each pair of trays the press cloths are folded, so as to form a bag through which the water is filtered. The cloths are made of finely woven cotton, so fine that while the water will, under pressure, readily pass through them, the clay is left in the bags. The grooves in the trays are cut in order to allow the water to trickle away. A pressure pump is used to force the slip into the press, but before the pump is put into operation the whole of the trays are clamped together by iron rods, having deeply cut worms at the end, and double bolts to ensure the necessary strength. When the press is nearly up, the pressure from the pump is very great indeed, and it is just as well so to arrange the press that no one can get hurt if by accident the screws are stripped off the rods. Cloths used in the slip press are usually dressed with chemicals to prevent rotting, and in this condition certainly last longer than the undressed ones. As a further protection, outsiders are used. These are cloths of a coarser grain, and altogether of a cheaper variety, which take the bulk of the outside pressure, and certainly lengthen the life of the inside and more expensive variety. Cloths should have great care, as they are expensive, and, unless kept clean, will prove to be a very big item in

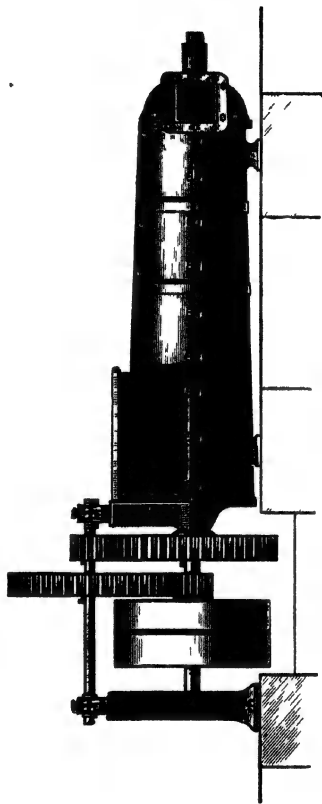


FIG. 6
PUG MILL

the accounts. It thus follows that at least once a week all cloths should be washed in warm water, and hung up to dry, so as to be ready for the following week's work. The slip is introduced to the cloths through a series of taps made of gun metal or brass. These taps are connected with a pipe that runs the full length of the press, and one tap supplies each chamber. In the middle of each cloth or bag is a hole, fitted with a metal nozzle, so arranged that it can be bolted to the tap situated exactly above it on the delivery pipe. This arrangement is necessary, so that, if one cloth should be burst, the particular tap that controls the supply to this cloth can be shut off without interfering with the remainder of the press. When, in the judgment of the operative, sufficient pressure has been applied, the pump is stopped and, after the nozzles and screws have been released, the delivery pipe is suspended by a hook 2 ft. above the top of the press ; the holding rods are lifted out of the way, and the press can be readily opened. It will be found that the clay lies in the bags when unfolded looking almost like corrugated sheets of clay. With the aid of a copper or similar scraper, measuring about 5 in. by 6 in., the clay, which sticks to the cloth, is gathered together, and the whole mass rolled up and carried away. The cloths are then refolded ready for re-filling. It will be readily seen that burst cloths can be a source of great loss, so that it has been found necessary for the water from the press, which may carry with it a certain quantity of slip, to be drained into an ark or arks, in order that its clay contents may be allowed to settle, thus preserving it for further use, instead of it running away to waste. A great deal of attention should be paid to the press. It must be kept in good sound condition, so that probably the best type of wooden press, owing to its lasting qualities, is made

of oak. The principle of the whole operation is filtration by pressure, so that this particular press is known throughout the trade as the filter press.

The Pug Mill. In order to render the clay perfectly homogeneous, and usable, before sending it on to the makers, it is treated in what is known as the pug mill, where spiral knives cut and knead it, until it is discharged at the mouth of the pug as a damp but firm mass, from which lengths are cut ready for the use of the potter. It is quite easy to spoil the clay by faulty pugging. To obtain good results—the pug must be of the right type, must always be kept clean and in *good condition*. The clay should be allowed to age in a damp place, free from draughts, and on no account should soft and hard clay be put together into the pug—"slurry" in the pug mill leads to disaster.

The use of the pug mill is not always possible, for in the finer grades of china, and for pressed articles, such as dishes, sweets, etc., the process of wedging is applied in the preparation of the clay before use. The object of this is the same, namely, to render the body as usable as possible in the hands of the potter. The process consists simply of cutting the slab of clay through the middle with a wire, and with great force banging one half of the cut mass on to the top of the other, taking care to keep the grain of the clay always in the same plane, and repeating this process over and over again, until every particle of unevenness has been taken out of it. The ordinary process of pugging does all this, but it can never replace the hand method for the most exclusive types of pottery.

CHAPTER IV

POTTERY MANUFACTURE

"And the vessel that he made of clay was marred in the hand of the potter; so he made it again another vessel as seemed good to the potter to make it."—(*Jer.* xviii, 4.)

THERE are various processes employed in the making of pottery—throwing, pressing, casting, and jolleying. Some pieces cannot be made by the first process, and in that case the second, third, or fourth method is employed, and sometimes it happens that a combination of two methods is necessary to bring about the desired result. After the making come the finishing processes—fettling, towing, scolloping, turning, and handling.

Throwing. There is a fascination and romance about the thrower's wheel, that probably causes it to be the most interesting of pottery making processes. It is one of the oldest crafts, and, although the machine used to-day is modern, the method adopted by the thrower is not far removed from that used by the earliest potters of antiquity. The old type thrower's wheel was a very simple arrangement, consisting of a big disc carrying a spindle which supported the thrower's block on which the ware was made. This disc was revolved by foot, and probably this was the origin of the name "thrower's wheel." The throwing of the ball of clay on to the revolving wheel has probably resulted in the process being called "throwing." The wheel has a flat disc or table measuring 8 in. to 12 in. across, and is attached to a revolving spindle, which, by a clever

mechanical device operated by a foot lever, can be made to revolve at various speeds, controlled at all times by the thrower himself.

In cup making, first of all the linings are made. These linings are just a rough outline of the desired shape. A lump of clay is weighed on the scales by an attendant, the thrower takes it in his right hand and, with great dexterity, throwing it on to the revolving disc, he fastens it there, and immediately starts to work up the plastic clay until first it resembles a cone, then squeezes it down again into a flat round mass, then up again and down again until gradually he shapes it into the form desired. If the ultimate object is a teacup or breakfast cup, the foregoing process is carried out very rapidly. When the linings are made, the disc on the thrower's spindle is replaced by a brass chum, which is a hollow receptacle made to fit exactly the outside of the cup mould. (See Figs. 7 and 8.)

It seems quite a simple matter to press these linings of clay on to the sides of the revolving mould, but it takes some years for an apprentice at the trade to master this operation, and even then, he always has to be on his guard, lest uneven pressure at any part should set up a condition that would spoil the ultimate article. It is quite easy to bring out a straight-sided cup with a flanged top, or a tucked-in top, by varying the pressure during the throwing process. Naturally, if a cup is straight to begin with, the potter wants it to be straight when finished, and all through the making of the china teacup, in the throwing, turning, fettling, and handling, great care has to be taken to see that no strain is imposed upon the soft clay that would later develop into a serious fault.

Many articles are still made on the thrower's wheel, such as egg-cups, vases, teapots, candlesticks, and fancy

pieces of all descriptions, in the same way, without the use of moulds, as in the early beginnings of the industry. These articles are finished as far as it is possible by the thrower, and then after drying are turned on a lathe to the required shape and size.

Looker to Ware. The man who carries away the filled moulds from the thrower is called "the looker to ware." His duty is to supply the thrower with the necessary moulds, and to carry them away when filled into the drying room. As the clay cups dry, contraction takes place, and when ready, the attendant empties the moulds by the simple process of turning them upside down, and placing them on the work board, preferably *on their feet*, and not more than two high, that is, one inside the other. As the cups are more or less soft when being removed from the moulds, great care has to be taken not to set up any strain. A man must be an expert to handle the ware in this state. One other point is very important. The work boards must have a level surface, for a slight unevenness on the board may result in setting up a strain that will inevitably lead to loss in the later states of manufacture.

Turning. Practically all thrown ware has to be turned afterwards in order to remove unevenness from the outside surface, and in the case of plain cups, etc., to finish the edge. It often happens that a shape is made in such a way, that the final form is arrived at only after considerable alterations in outlines on the lathe, and, in a case of that sort, there has to be a close understanding between the modeller, thrower, and turner. The turner's lathe is very similar to a wood turner's lathe, and is generally worked by a foot treadle, but sometimes by machinery. Thrown or jollied cups, as they come from the moulds, are more or less rough on the surface, and it thus happens that the turner has to



FIG 7
THE THROWER

shave away all this roughness and to turn and finish the foot. His tools are of various shapes, made of sheet iron about $\frac{1}{16}$ in. thick, 8 in. long, and $\frac{1}{4}$ in. to 2 in. wide. These tools are easily sharpened to form a cutting edge, and may be shaped to form a knife, grooved, for the foot of a cup, or turned almost at right angles at the bottom to form the shaver. It is quite interesting to see the shavings of clay fly from the article being turned after the turner has deftly fastened it to the chuck ; to note the way in which the attendant reverses the lathe, and finally to handle the finished article. A turner's lathe is used for many purposes in pottery making. Besides simply turning tea and breakfast cups, teapots of the Rockingham and Samian type are sometimes finished on the lathe ; inlaid bands, rough surfaces, and colours are applied in many varied styles. A turner must have a good idea of line and shape, or many of the pieces he handles will be spoilt and rendered useless. In the electrical trade many of the articles made by the potter receive their final form and finish on the lathe ; and, indeed, only the cheapest types of hollow-ware made from clay can be potted without the finish and form which is the object of this process. Sometimes the turner finds that the ware sent to him has not been made with the proper thickness of clay in the right place, and it then happens that he is unable to get the shape required. It may be too thin on the shoulder or foot, and his tool bursts the article in question. Clay ware has to be what is called leather hard before being turned. It must be neither too soft nor too dry. If too dry it will shatter and fly on the lathe ; and if too soft it is very liable to be strained, and this strain may not be perceived until after the first firing—slight cracks and crooked pieces are then very liable to occur.

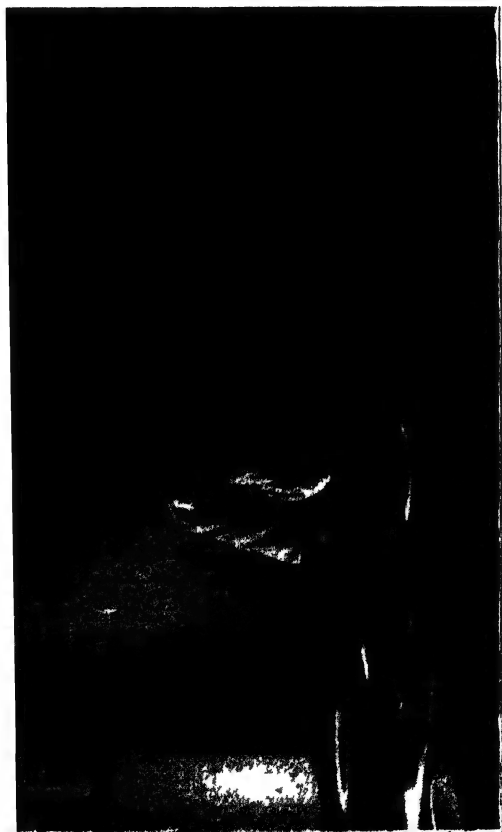


FIG. 8
MAKING A TEACUP (THROWING)

Let us now take, for instance, a cup. The turner's attendant takes this from the board, and puts it into the left hand of the turner, who fastens it on to the

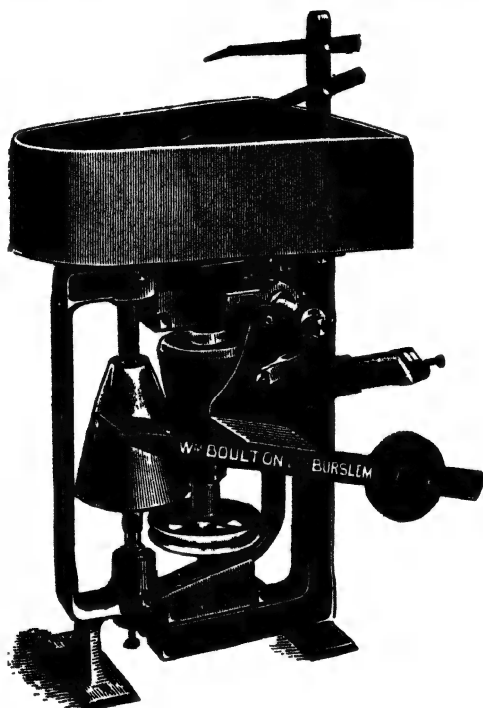


FIG. 9

THROWER'S WHEEL

chuck, or as it is more generally called in the trade the "chock," made of tapering wood having a metal screw, which fastens it on to the end of the turner's mandril. The chuck is made to revolve away from the turner as he brings the cup into position. Great care has to be



FIG 10
TURNING A TEACUP

taken to see that it is exactly centred, and by a deft process with a small iron tool the cup is fastened on to the chuck. The lathe is then reversed, and the turner begins to shave away all excess, and to form gradually the shape desired. Each lathe is fitted with a rest in order that the workman's hand may be steadied during the process. The clay is so delicate and so easily broken that the tool is rested on the fingers in such a way that they act as a shock absorber, giving, when there is not too great resistance, but gradually forcing the tool to obtain the desired outline. The foot is then shaped with another tool made for the purpose, the mandril reversed, and the final polishing having taken place the cup is cut free from the chuck with a sharp tool. Of course, it has to be supported by the hand or it would fall and break, and, indeed, the hand forms a support through quite a large part of the turning process. Another tool is used for rounding off the edge, supposing that it is an entirely plain cup that has been turned. Sometimes it happens that the edge has to be scalloped afterwards, and in that case the finishing by the turner is unnecessary. Turning is certainly a very interesting process, and its uses grow from day to day particularly in connection with the electrical trade. If a turner does bad work it invariably reveals itself, sometimes before the article is fired, and always, afterwards. Thrown and turned goods are still to-day the most popular type of pottery, and this might be illustrated by giving descriptions of the turning of very expensive fluted vases which are made in quite a wonderful way at one or two of our old established factories.

Handling. The men or girls who fasten on the handles are known in the trade as handlers. Usually those who do this work do nothing else. It is a trade by

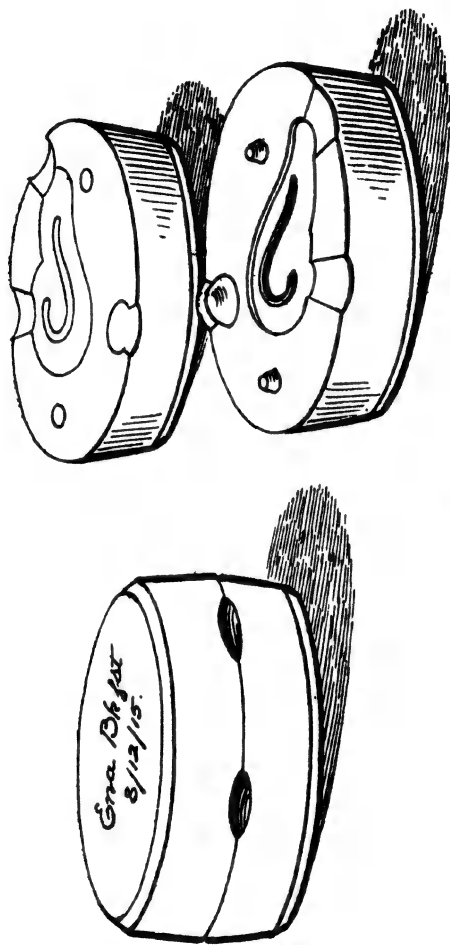


FIG. 11
CUP HANDLE MOULD

itself, and like other pottery trades it is not very easy to train a girl to become really expert.

For the purpose of making the handles before they come to the handlers, moulds are made. These are in two parts—one part forming half the handle, and the other part forming the other half. When the two sides of the mould are placed together with a roll of clay in the required position, pressure is applied in such a way as to form the complete handle (Fig. 11). The newer process is very similar except that twelve handles can be made in one mould by the use of liquid slip. The slip when poured into the mould, forces its way into the crevices, forms the handles, and these, after drying, can be easily removed by the girls ready for fettling. This fettling of the handle is done with a small knife and soft sponge, the knife cutting off the surplus, and the soft sponge finishing the process. Here, again, great care is necessary or the handle will be strained, and once strained it is almost bound to come out of the oven more or less crooked. It is a rule in the trade, particularly the china trade, that a soft handle must not be attached to a drier cup, neither must a dry handle be attached to a soft cup, but the moisture in both handle and cup must be as nearly as possible the same. Otherwise contraction varies, and we get cracks developing at the point of contact between handle and cup.

Years ago we developed a theory that if a cup was perfectly straight when it went into the oven, it ought to be perfectly straight when it came out again. This means that if no strain has been imposed on the clay cup at any period during its process of manufacture, the resultant article should be perfectly round when ready for firing, and if perfectly round and true, one boxed on the top of the other should be sufficient to keep

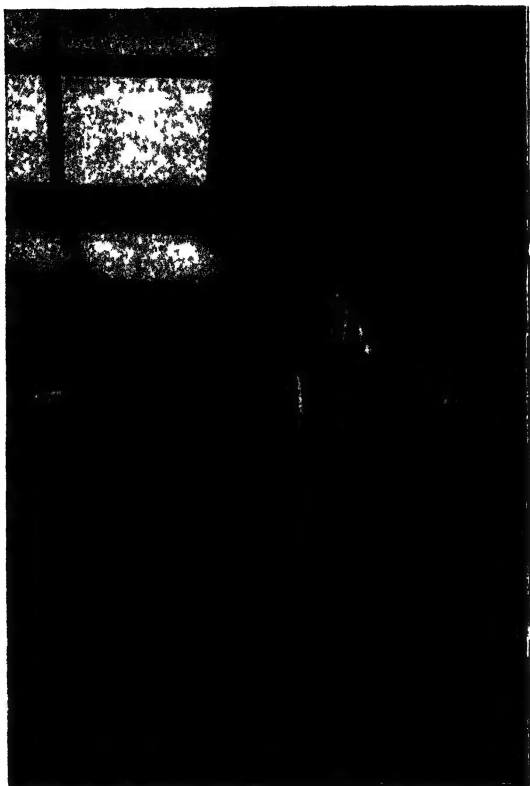


FIG. 12
FIXING HANDLE ON CUP

both cups straight without the use of any other means such as rings, etc. It has been proved in almost all cases that the above theory is correct, and thus the cost of making rings is saved. It is further proved that in practice this simply means a higher standard of efficiency amongst your workpeople, greater care on the part of your management staff, which is all to the good, and the result obtained is quite as good if not better, in most shapes made, than would be obtained by the more expensive ringing method.

The handler's tools consist of a fettler made of iron, and sometimes even a horsenail has been ground down and used for this purpose when the proper tool has not been available ; a series of sponges, a knife, a bowl containing liquid slip, and a bucket of water, if these latter may be called tools. They also have their bats to hold the handles, these bats being made of plaster, and various receptacles to keep the handles in proper condition ready for fastening to the cups. The handles are usually fettled some few dozens at a time, probably sufficient at a time to do a board of cups. The final process consists of fixing the handle in its correct position on the side of the cup in a perfectly upright line, and in such a way that it shall form, after drying, a permanent part of the completed article. This fixing is done by means of the liquid slip. It adheres to the clay body of the cup almost with the tenacity of glue. Once fixed all the spare slip has to be trimmed away with the trimming tool. It will be readily seen that in this comparatively simple process, it would be quite easy to strain the fragile cup. Sometimes no sign of this strain appears until, under the influence of the fire, cracks and crookedness develop, and thus cause unnecessary loss. The cups thus finished are now ready for the first fire, which takes place in the biscuit oven.

They are stored until wanted in long stillages in the handler's workshop, and presently are carried out to the greenhouse for examination by the foreman of the department, and from thence passed on to the placers.

CHAPTER V

FLAT MAKING

Flat Making. Such articles as saucers, plates, etc., are made by the flat pressers in various ways. The jigger is the machine on which these articles are made. In the old days this was driven by hand-power, but now it is usual for an endless rope, driven by steam-power or electricity, to be utilized for this purpose. The jigger consists of an upright spindle, an arrangement of pulleys, and a lever, which are able to revolve it at any desired speed. On the top of the spindle a head is fixed, sometimes of plaster lined with lead, but more usually of brass or gun metal, shaped in such a way that the bevelled natch at the back of the plaster mould fits exactly the brass head of the jigger. On pressing a lever the arrangement of pulleys already referred to causes the endless rope to come in contact with the spindle pulley, thus revolving it at any given speed according to the pressure applied. The jigger is surrounded by a lead-lined box to prevent any surplus clay flying on to the floor, and at the back of the box, in line with the jigger itself, is a standard containing an arm which carries the profile. This arm is operated by hand, and is capable of forming, in a downward direction, the arc of a circle.

At the side of the jigger is quite an interesting machine called the spreader. This is used for pressing out the clay to the required thickness before actually making into saucer or plate. By pressing a lever the machine is set in motion, a batting-out tool descends on to the ball of clay placed on the plaster block, and on

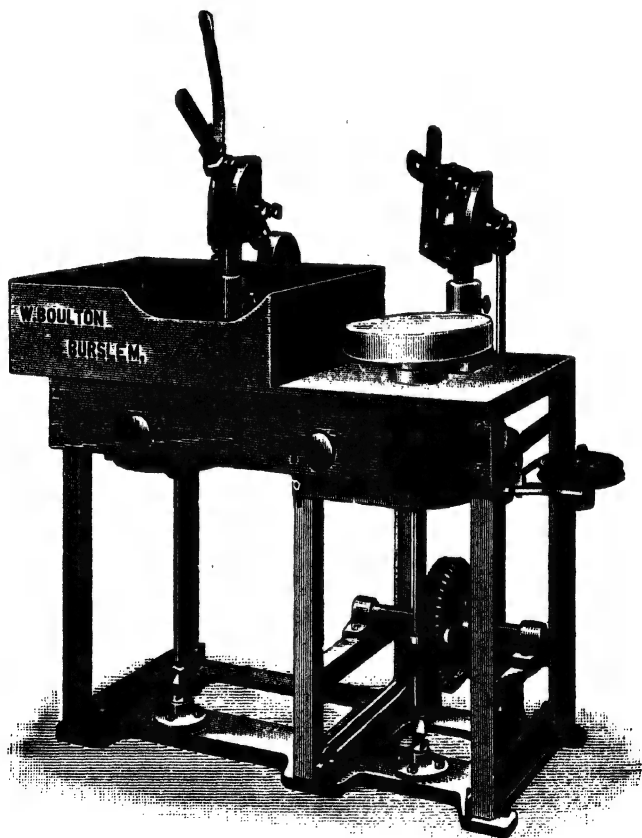


FIG. 13
SPREADER AND JOLLEY

completion of the process ascends to its original position. In the old days this batting-out was done by hand, and the invention of this machine has been of very distinct advantage to the pottery industry.

Before describing in more detail the actual making of a piece of ware on the jigger, several points of great importance in flat making should be mentioned.

We must, first of all, consider the making of the moulds. It is necessary to standardize the natches for any given size of saucer or plate. In order to make it as simple as possible, the number of natches are reduced to a minimum. All small articles would have one sized natch, 6 in. one sized natch, bread and butter plates, 10 in. service plates, and dessert plates another size, but the quantity must be kept as low as possible in view of the great difficulty found in obtaining and keeping a perfect standardization. The system adopted by a modern factory is as follows—A standard natch is turned in hard metal. This is called the male natch. All blocks or originals are turned exact to this standard. A hollow natch is also turned in metal, in which the blocks can be fitted as a test before being used for making the cases and moulds. The difficulty in connection with this process is that certain allowance has to be made for an unavoidable swelling in the plaster, but given the proper experience and knowledge this difficulty is readily overcome. It will now be seen that the final mould, made on the lines indicated, should be of a standard size. It is therefore necessary to see also that all the brass or lead-lined heads used in the flat-making department are standardized in a similar way, and for this purpose an original steel natch is used for testing, and all heads are turned to this standard. We thus have perfect fitting moulds, and without this perfection it would be quite

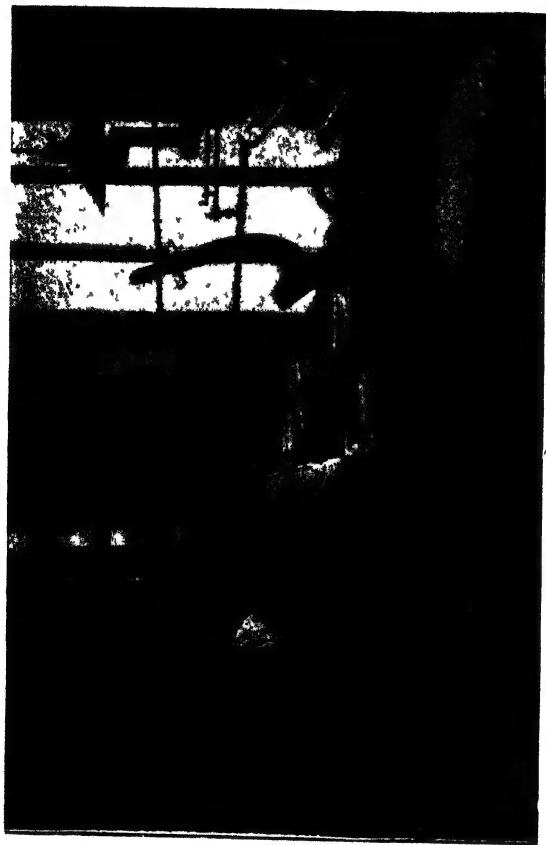


FIG. 14
PLATE MAKING

impossible to get the results which economical and successful manufacturing make so necessary.

Another matter of great importance in connection with the making of flat ware is the preparation of the clay, i.e. the wedging or pugging. Sometimes it happens that the clay body has been imperfectly prepared in the sliphouse. The materials may have been burnt on the drying kiln, insufficiently sifted, or badly pugged, and the resultant loss, both to workman and manufacturer, is most serious.

Having, therefore, considered all these points, we will proceed to describe the simple making of a piece of flat ware. A ball of clay of the requisite size is placed on the spreader, a lever is pressed, and the tool flattens it out to the desired thickness. The clay bat is then taken up by the flat presser in quite a deft manner, and thrown forcibly on to the mould which has been already fitted on the jigger head. Pressure is then applied by hand, the profile is brought down on to the revolving mould, and the outline of the back of the article is formed. The mould itself forms the inside. All spare clay is cut away from the mould with a knife, leaving only the saucer in a more or less finished condition. Sometimes it may be necessary to polish these articles. This is done by allowing them to dry for a short time, then replacing them on the jigger head, and finishing with a clean profile and damp sponge. The moulds are then carried away by the attendant, placed in the drying chamber, and allowed to stay there sufficiently long to cause the clay to contract and free itself from the mould. The ware is then lifted off, placed on boards, and the moulds are ready for re-use. A saucer mould will probably last for a thousand saucers if carefully used. This process applies to all kinds of flat ware.

For some types of flat ware, such as 10-in. china plates,

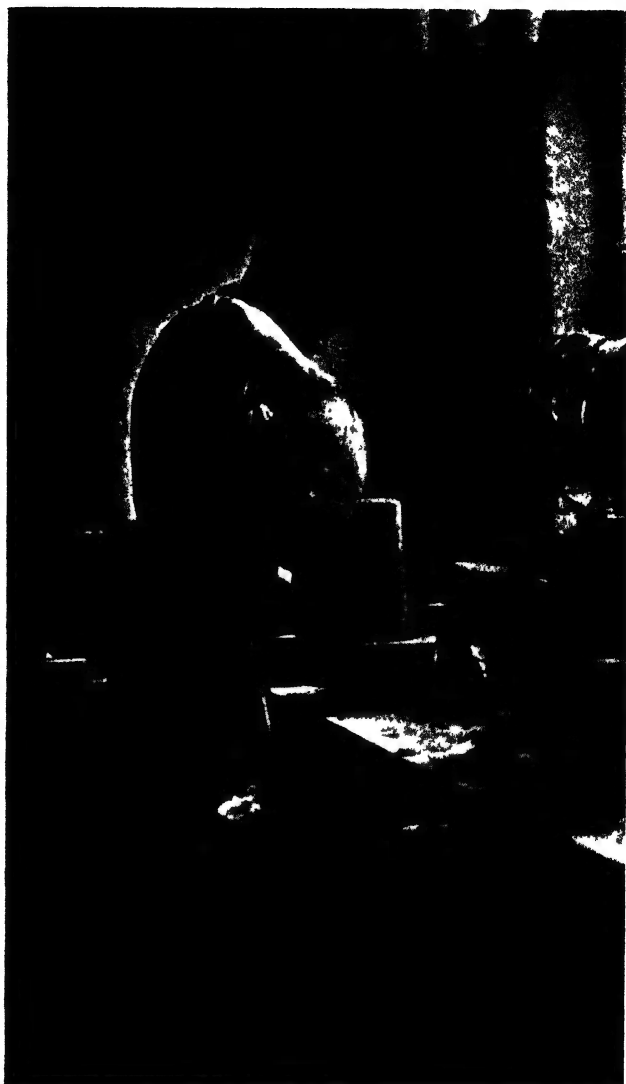


FIG. 15
CASTING JUGS

it is the general custom to substitute handwork for the mechanical profile, and the clay is generally wedged by hand, the back of the article formed by hand, and for the final outline of the back only a pitcher tool or profile is used. The only part of the machine that is actually in use in this case is the rope-driven jigger itself.

The process may seem very simple to the casual observer; but here again the quality of the workman, and his almost instinctive knowledge, controls the ultimate result. It is possible in the making so to manipulate the clay that the resultant loss is prohibitive. Here, certain definite rules have to be carried out and observed always. Nothing seems quite straightforward and simple, even in the making of flat ware.

Similar machines, slightly modified, are used for making hollow ware. Cups, slops, and vegetable dishes are often made in this way, and it has been found possible so to arrange the machine that it not only revolves, but has also an elliptical or square movement, which enables the maker to utilize it for the making of oval pieces as well as pieces that are practically square. The square-making machine is not in use to any great extent, as there is a limit to the articles to which it can be applied, but it is used very successfully for the making of square bread and butter plates, and other simple articles, and can be referred to as a very fine mechanical achievement.

Casting. This process is more modern than any previously mentioned. The clay is used in the slop state, and is known as "slip." It has to be carefully sifted, and freed from bubbles. Often it is aged for long periods in storage tanks before being actually brought into use. For casting purposes, the moulds are usually kept in a warm condition, whether it be cup, teapot, ewer, or lavatory basin. Many articles

that could not possibly be made in any other way can be readily manufactured by casting. The liquid slip is poured into the mould, and the plaster, being porous, draws out the water from the slip nearest to it, causing a coating of clay to form round the sides of the mould. The thickness of this casting varies according to the length of time the slip is allowed to remain in the mould, and frequently the maker has to pour in fresh supplies of slip owing to the suction of the plaster. When the necessary time has elapsed to form the thickness desired, the spare slip is poured away, the mould is placed in the drying room, and when sufficiently dry the cast article can be readily removed. It is possible for moulds to be in one or even a dozen pieces according to the shape. It is most interesting to inspect the making of such articles as birds or figures. Sometimes you will see the maker with some dozens of wings, feet, heads, or arms, lying on bats which have been cast in separate moulds, and which are waiting for the final assembling necessary to form the bird or figure. The articles usually made in the china trade by this process are teapots, jugs, coffee-pots, marmalades, honies; and in the earthenware and sanitary trade, cwers and basins, lavatory basins, and all kinds of sanitary goods. This has been rendered possible by the discovery of the use that can be made of silicate of soda and soda ash, which on certain clay bodies has quite a remarkable effect, causing a very thick slip, having very low contraction, to become reduced almost to the consistency of water, thus enabling it to penetrate into all parts of a mould, and simplifying this process of manufacture in a most remarkable way. Great strides have therefore been made in the application of casting processes. When the articles are removed from the mould they have to be finished, and all rough edges smoothed away. Soft

sponges and india-rubber pads are used for the sides and the article is dried previous to being taken out to the ovens.

Drying Stoves. In all processes of pottery making, drying stoves are almost an absolute essential.

It has been found with regard to the ordinary square stove, built in the form of a little room, and often containing a stove pot, that one great improvement could

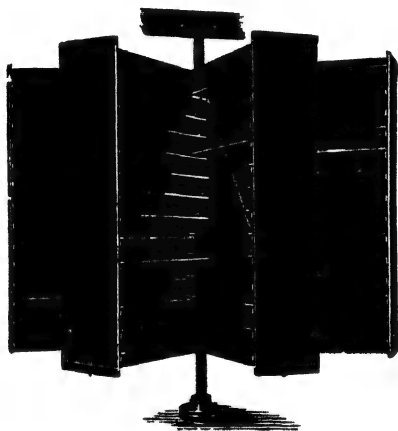


FIG. 16

DRYING STOVE

be effected by having an expansion chamber, supposing there was sufficient room for one, at the top of the stove, thus allowing the heat to rise and find its way out into the open air through a suitable outlet.

Many new enclosed stoves are very simple in their construction, and are not too expensive to build. Manufacturers who are alive to their own interests would certainly be well advised to get all the information they can with regard to these particular types, which are an undoubted

improvement upon the stoves most generally in use to-day. The great outstanding advantages of the new type of stove are—

1. Great efficiency.
2. No need for the workers to enter the stove at all.
3. The practical elimination of steam, etc., from the actual workshop itself.

CHAPTER VI

SAGGAR MAKING

Saggar Making. One of the big essentials in a successful pottery business is a good saggar. Without it losses are excessive, and in view of the fact that the actual cost of making forms such a large percentage of the final value of the ware itself, it will be readily seen that a faulty saggar means ultimate failure. It might be explained here that the saggars are the receptacles in which the china or earthenware is placed to protect it during the firing processes. These saggars vary in size from 12 in. in diameter, and 3 in. to 7 in. high, up to even 2 ft. or 3 ft. A fireclay mixture has been found most suitable for the purpose of making saggars. Probably one reason why the pottery industry was established in this district was the proximity of a reasonable quality of fireclay, in addition to the coal which is found in such big quantities in the district. Another reason was that some of these clays were found suitable for the actual making of pottery itself.

In dealing with saggar marl great care has to be taken first of all in the selection of the type of marl most suitable for this particular work. A saggar that is entirely suitable for china biscuit is not suitable for china glost, owing to the difference in the temperature. The ideal thing with regard to saggars would certainly be to subject every saggar, during its first fire, to at least 200 degrees more temperature than would ever be necessary during its after life. The effect of this would be to take out all contraction, and to render the body hard and impervious. The loss in saggars, which is a

very big part of any pottery manufacturer's weekly expense, is largely due to dunting or cracking, and failure to withstand the temperature applied. The greatest loss is found in china biscuit saggars. Life here is rarely more than five times, and in any moderate sized china works, the expense of making saggars is probably quite £2,000 to £3,000 a year. Earthenware saggars, owing to the lower temperature, and to the fact that no bedding is done in this process, have generally a much longer life, lasting as long as twelve to even twenty-five times, thus considerably reducing the cost of manufacture.

Free iron has been one of the chief troubles found in fireclays, particularly of the local type, and many experiments have been made to get over the difficulty caused by this. Even ball clay has been used, but most generally the finer qualities of Stourbridge fireclay have been adopted in conjunction with local marls in order to produce a reliable saggar mixture.

Weathering of saggar marls has been very largely advocated by experts for many years. This simple process of leaving the marl in heaps out in the open air has the effect of showing up any nodules of iron which may be there. These nodules can readily be picked out owing to the fact that they show signs of rust, but this is a very slow and laborious process, and it is far better to obtain a clay that is free from this objectionable iron. Weathering renders the clay more plastic, and certainly improves its wearing qualities. Saggar marl by itself is unfit for use, owing to the fact that it fractures so readily when cooling. It certainly has to stand very quick changes of temperature both when the oven is firing, and when the firing process is finished, even though every care is taken in this direction. Various methods have been adopted to cause the clay to become more

open. Sawdust, charcoal, and coke have been mixed with the marl for this purpose, but the most general method is to add a certain percentage of grog, which is made from broken saggars ground on a suitable pan, and sifted and graded in such a way so as to obtain the size of grog found to be most effective for the purpose. Sagger marl, then, consists of a mixture of local or Stourbridge fireclays mixed with grog in a proportion of somewhere about 45 grog to 55 clay. By mechanical means or otherwise this mixture, with water added, is stirred up and finally pugged or mixed on a mixing pan until it is in a condition suitable for making into saggars. The mixture is sometimes then stacked away to give it time to age, and, finally, wheeled into the sagger-maker's place.

Here the saggars are made by batting out the bottoms in circular or almost square iron frames the exact size necessary. The sides are formed by batting out great slabs of the clay on an iron frame, measuring about 5 ft. by 3 ft., cutting these into strips, and folding the strips which form the side of the sagger round a drum or wooden mould previously placed on the already prepared bottom. The two ends of the strip are joined by water and pressure, the side fastened to the bottom by a plucking up of the spare with the aid of a wooden plucking tool, and the whole is finally smoothed off and finished, the mould removed, and the sagger carried away into the drying room, where it stays for two or three days until completely dry. Every oven that is fired contains its necessary quantity of new or green saggars. If the saggars are subjected to the fire when in a wet condition, it undoubtedly takes a good deal from their ultimate life. They must be dried thoroughly before firing. It is customary to put some small articles or light articles in these green saggars so as to economize

this cost of firing, but even this has the effect of spoiling a certain percentage, and undoubtedly the loss in saggars would be much less if it were possible to adopt the idea already referred to of subjecting saggars to a special firing before being brought into use.

CHAPTER VII

GREENHOUSE AND BISCUIT BAKING

USUALLY there is a large room fitted with stillages in each factory into which the ware, after making, is carried for looking over or inspection. This is the manager's own peculiar workplace. Here he is able to check faults, and so supervise the work done that the standard of the manufactured products may be maintained.

The method adopted for counting out ware to the ovens varies in different factories. In one there may be no necessity to carry it out at all. Saucers, etc., as they are made, are placed on revolving dobbins which can be locked or unlocked by the manager at will. On one side the workman fills the dobbin. When filled it is unlocked, swung round, locked again, and the quantity credited to the workman's account. The placers are on one side, the workmen on the other. It is only then a matter of emptying the shelves into the saggars, and thence to the ovens. In the case of another factory the process may be much more complicated. The order is given to the handlers to carry out. They then take their own work, which has meanwhile been stored in stillages at the back of the benches, out to the greenhouse. Each board is counted and the total entered in the handler's settling book. When the week's work is finished, and settling time comes, the total of the handler's work is counted, and entered into a summary book containing the names of the various handlers and the various shapes manufactured. When all the handlers have been settled with, the totals of each shape

are added up, and from these totals the scollopers, turners, throwers, and the looker to ware, claim their quantities. It might happen that sometimes quite a lot of the thrower's work has not been turned and handled. He therefore has to draw on account or make some arrangement with the management that will enable him to obtain payment for his work.

When in the greenhouse this ware is looked over, blow bellows are used to free it from any accumulated dust, bad pieces are turned out, and where necessary the ringing or sticking-up process necessary to keep the ware straight during the firing takes place. Once the ware has been checked and examined, the manager supervises the further dealing with same, giving the necessary instructions to the placers which particular quantities he needs for his orders, so that the greenhouse not only becomes the looking-over place, but practically the central clearing-house for the clay ware manufactured on the works.

We will first of all consider the placing of a china biscuit oven. This is simplified to some extent because china biscuit has not been fired successfully in this country with any of the gas-fired continuous ovens. The time is coming undoubtedly, however, when the difficulties connected with this will be successfully overcome, and the principle of gas firing will establish itself even in this branch of the industry. The type of oven used is the ordinary up-draught. The size of the oven itself may be anything from 12 ft. to 20 ft. in diameter, and about the same in height. It consists of a round brick structure, having walls 14 in. to 18 in. thick, covered with a dome or arched roof, the whole built of fire bricks, and held together with a dozen or fifteen iron bands, which run right round the circular oven at a distance of about 12 in. from each other.

These bands have the effect of holding the brickwork in place, and preventing it from moving during the time of expansion and contraction caused by the firing and cooling. The brickwork would soon fall to pieces were it not for these containing bands. A doorway is built in the oven surrounded with an iron frame to give strength and solidity, and this doorway forms the entrance. The heat for firing purposes is generated in the mouths, which are built at equal distances as near as possible round the oven, much in the same way as one sees in the ordinary brick ovens dotted up and down the country. A later type of oven has a perfectly flat bottom. Underneath this bottom flues are arranged to carry the heat from the mouths to the centre. In the centre is a hole, measuring about 12 in. to 15 in. across, thus enabling the fireman to obtain a more even temperature throughout the whole mass. The oven itself is surrounded with a bottle-shaped hovel. This hovel leaves sufficient room round the inside for the firing attendants to fill the mouths of the oven with the necessary fuel. Its height, finishing at the bottle neck, should be about 60 ft., and it is the outside of these ovens that visitors to the Potteries are able to see in every direction. It seems quite a simple thing, once you have seen an oven, to build one exactly like it, but each one, as a fireman will admit, varies in its qualities. No two ovens fire alike. This may be due to some slight alteration in the design, or to a variation in the position which gives a different type of draught. There are one or two points, however, that should be observed in the building of ovens, particularly for china biscuit. In the first place the height up to the shoulder of the oven itself should not at any rate be more than the width. The rise of the crown from shoulder to centre should not exceed

3 ft. Of course, bricklayers will object to this latter rule because of the difficulty of building, but the manufacturer who insists will undoubtedly reap great benefit from the decreased loss and the more successful firing. An example may be given of an oven that was very difficult to fire. The width was 15 ft. 2 in. ; the height from bottom to shoulder was 15 ft. 6½ in., and the rise of the crown 3 ft. 9½ in. This was altered owing to continued bad results so that the height to the shoulder was 15 ft. 3½ in., and the rise of the crown 2 ft. 9 in. The oven then fired successfully without any of the trouble connected with it previous to alteration. The mouths for a 15 ft. diameter biscuit oven should be 3 ft. 10 in. long, 3 ft. high, and 2 ft. wide. From the end of the bar to the solid bottom measures 15 in. Another point to mention is that it is just as well to have the bags, which carry the fire from the mouths into the oven, and which are really brick-wall protections to protect the saggars from extreme heat, too high rather than too low, and 6 ft. bags might be regarded as a satisfactory medium.

Into the completed oven the placers then begin to carry the saggars of ware. In the case of hollow-ware the saggars are filled with cups either boxed, i.e. placed face to face sometimes stuck together with adhesive compound, or fitted with rings made from the same body, formed with a groove, and so shaped as to prevent the cups during firing from going crooked. The bottom of the saggar is covered with a thin layer of powdered flint. This flint is practically pure silica, and is infusible at anything but a very high temperature. It can be safely used for the purpose we have in view. As many articles as possible are placed in the saggar. One point of importance should be mentioned, however, and that is, do not pack your ware too tightly. Allow just a

little space for the expansion which may take place during the early stages of the firing. Great care has to be taken that the saggar bottoms are perfectly level. Otherwise, you are bound to get crooked ware. If the fireclay of which the saggars are made is faulty, and contains iron, this iron will undoubtedly affect the final quality of the ware. Hollow-ware can only be placed in certain parts of the oven. Experience alone can teach one the limits of temperature which it is able to stand. It is obvious to anyone that the temperature will be higher at the generated point than it will be farther away. It is therefore usual to place bedded flat ware in what is known as the "prick of the fire." Here both saggars and ware have to stand the highest temperature, and it is here that most of the loss in firing biscuit ovens takes place.

There are various methods of placing china flat ware, and the common and general method may be divided into two parts—flinting and bedding.

For flinting, a setter is needed, very similar in outline to a saucer. This setter is made of a special body, which may roughly be given as

One of Ball-clay

Two of Fire-clay

One of Grog

made from ground setters. A soft bed of flint is scattered over the inside of the setter, and saucers are placed in this, each one separated by a bed of flint, and, finally, all apparent space is filled by drawing up handfuls of flint, and filling the top saucer with the same material. These setters containing the bungs of saucers are then placed in the saggars, and the saggars carried away to the oven.

The bedding process varies in this respect—no setters are used. Instead of being placed face upwards as in



FIG. 17
BEDDING CLAY FLAT WARE

the flinting process, the ware is placed face downwards, and is rubbed into the flint so as to form its own bed. We may thus have space for three bungs of muffins in one saggar. The process of rubbing in on to a small pile of flint placed on each muffin is repeated until the saggar is full. Here again a little space is left at the top to allow for expansion, or for the dropping of the bottom of the saggar above during the firing process.

In the case of expensive pieces like 10 in. plates, or the products of the fine china makers, a separate setter is used for each piece. This setter differs from the setter used for flinting, in that it is more like a small saggar itself, in which the single piece of ware is placed and protected during the firing process. Naturally, this is a much more expensive way of placing than those previously described, but for certain articles it has proved to be the most satisfactory.

An oven may contain anything from 50 to 120 bungs, each bung consisting of 12 to 18 saggars placed one on another. In addition to these bungs the top of the oven, underneath the crown, is usually filled up with some hundreds of unfired saggars. These are necessary to replace the wastage in the saggars actually used for placing purposes. As soon as the oven is filled, the clamping bricks are placed in position, and the doorway built up with loose bricks which are plastered over with sand in order to keep out the cold air. At various points round the oven, in the body of the oven itself, holes which are closed with a loose brick and sand are left so that the fireman can draw out from time to time his trials. These trials are placed in saggars having an opening, and can be readily removed with an iron rod. There is also a way left right to the centre of the oven, and here again the test pieces are so arranged to facilitate withdrawal. The trials used for china biscuit are



Fig. 13

sections of china cups, i.e. the actual body as used for the ware itself.

The firing of a china biscuit oven is usually a process which occupies about 60 hours. The first 24 hours must be carried on fairly slowly so as to drive out all moisture. If an oven is rushed at the beginning it always results in considerably more loss than usual. After 36 to 40 hours firing, it may be as well to draw out a round of trials. These may be six to ten in number, and the quarter where they are drawn from corresponds with the number which the fireman immediately marks on the withdrawn trial. He can see then at a glance if one quarter of the oven is in advance of the others, and from this time onward trials are drawn at intervals of three hours or less, right up to the finish. Only experience can teach the correct method of firing these ovens, which contain anything up to 3,000 dozens of ware. It is possible, by care and attention, to fire successfully, year after year, without any undue loss. When the firing is near completion, it often raises the question: "Shall I give it a little more, or shall I leave it as it is?" and this is the test of a fireman's ability. The trials must be translucent, that is, they must have the necessary clearness and almost transparency. If the trials lack translucency, you can depend upon it that the ware itself will be the same. It is generally desirable also that there shall be a slight smear or sheen on the surface of the final trials, but it is almost impossible to describe actually what is common everyday practice in the industry. One thing ought finally to be mentioned of supreme importance. At no period during the firing must the temperature be allowed to fall back. It must be a case of steady advance right up to the finish. Otherwise, some change takes place in the ware itself that renders it practically impossible

to get the right colour in the finished product. An oven that should be fired in 60 hours may go on firing for 90 hours with the most unsatisfactory final result. The fireman himself has a very responsible task. With each oven he usually has to spend at least one night and two days without any long period for sleep, and sometimes it happens that he has to be personally on the spot for even a longer period.

The firing of biscuit earthenware ovens is very similar to the firing of china ovens, except that the final temperature required is not as high as in the case of china, the earthenware temperature being 1,100 degrees centigrade, while china requires a temperature of 1,225 to 1,250 degrees. It is this extra temperature in the case of china that increases the losses, and makes the firing process so much more difficult. Sand, known as placing sand, of a special quality, is used instead of flint in the earthenware trade. The placing process is much more simple. Practically all cups can be successfully boxed, but even here one has to form certain definite rules for placing, and to take the same care during the firing process, or the result will be failure.

Various means are used for testing the temperature during firing. One favoured method is the contraction method, whereby a ring having a fixed standard of contraction is measured from time to time after being drawn from the oven and cooled. When the point of contraction is reached, which experience has proved to be correct, the firing process is completed.

Thermoscope bars and Seger cones are also used for testing the temperature during firing processes. These both have the same principle, but are utilized in different ways.

The Thermoscope bars are placed on a little fireclay stand, and melt at a given temperature. The stand

will hold four bars, the bottom bar melting at a lower temperature than the next one, and so on to the top. The fireman is able to observe these bars through the trial hole, and can see at once how the firing is proceeding.

Seeger cones, as already mentioned, are very similar in their action, but instead of being in the form of a bar, are little pyramids, and have the same quality of bending at various given temperatures. These can be observed in the same way as the bars.

In the case of glost firing, Thermoscope bars, Seeger cones, and the old type of red clay rings, dipped in a special glaze, are used. The latter was the trial most commonly used throughout the trade previous to the invention of the more scientific cone and bar. The fireman was able to judge the temperature by the darkening colour of these rings, and by comparison with a standard ring of exactly the right colour was able to tell when the glaze had reached the correct melting point.

Biscuit Warehouse. The cooling of an oven varies at different factories. Sometimes it is absolutely necessary to rush the cooling. In the case of glost ovens, the glaze is undoubtedly more brilliant when the cooling takes place quickly, but it is usually wise, to avoid loss of saggars and ware through dunting, to take as long over the cooling of the oven as for the firing. When the clammings are taken down, and the time comes for the emptying of the oven, this is done by a gang of men known as oven drawers. On many factories these are regularly employed for this purpose, and are kept on all the time. On others, however, more or less casual labour is used.

China flat ware has to be freed from most of the flint before being taken up into the biscuit warehouse. This used to be done by hand, and the process known as flat knocking. Recently, however, a machine has

taken the place of hand work. This machine is built in the form of a rocker having a quick motion, and the ware is placed in compartments. The little rocker moving backwards and forwards readily loosens the flint, and allows it to drop into a receptacle known as the flint ark. In the old days no dust-removing apparatus was used in connection with this process, but to-day most elaborate plants have been installed for this purpose, and the danger to the health of the operatives has to a large extent been removed. It is a fact, however, that great improvement can still be effected in this side of the china industry, and careful thought is being given to the problem.

Cups, etc., can be emptied straight into the baskets from the saggars, and carried away to the biscuit warehouse. Here, the looking over and cleaning process takes place. Earthenware is usually brushed off by hand, but several interesting machines are used for freeing china biscuit ware from adhering flint particles. One is known as the rumbler. This is a 5 ft. cylinder divided into sections which take small cages, in form almost like the sections of an orange. These cages have partitions down the whole length of them, into which separate pieces of china can be fixed. At the same time, 50 to 100 pounds of small graded china biscuit pitchers are placed in the cylinder. The doors are then closed, and the cylinder itself revolves by machinery. The cleaning process is effected by the tumbling on to the surface of the ware of a shower of these small pitcher particles. The machine is so arranged that the dust formed during the process is extracted by powerful fans, and discharged into collectors of various types. Twenty minutes to half an hour is necessary to clean a cylinder of ware, and a good deal depends on the efficiency of the ventilating plant, or

otherwise a film of dust will still be left, which has to be removed by hand previous to dipping. When cleaned and examined the ware is stamped with the trade mark, and passed down the lift, or carried to the dipping house.

Losses in biscuit may be due to various causes. Faulty workmanship in the actual making of the ware accounts for a great proportion. In the case of cast ware, blibs or small air bubbles may develop during the firing ; flat ware as well as hollow-ware will show up cracks which have been overlooked in the clay state ; wreaths, caused by faulty throwing or turning, will reveal themselves ; strain set up during any operation of the making or handling process will be easily recognized ; crooked ware and split ware may be caused by faulty placing ; hard fired, easy fired, split, blistered, or sulphured ware may be caused by bad firing. In fact there are so many faults due to so many causes in the pottery trade that it would be almost impossible to discuss them all.

CHAPTER VIII

DIPPING AND GLOST PLACING

ONCE the ware is cleaned, it is ready for the dipper. This is one of the important processes in a factory. It often happens in the smaller factories that every piece of ware that is made has to pass through the dipper's hands, and the success of the final result depends largely upon his skill. The glaze, as explained in a previous chapter, is a mixture of various materials, which, when fired on the ware, forms the glassy covering necessary to make the body impervious. The glaze itself is usually stored in big vats or tubs near to the dipping house. It is advisable to age the glaze as much as possible. Sometimes it is found that the glaze settles in the dipping tub, and this in itself may lead to considerable trouble, but simple means have been found to overcome this. The ideal, however, is to make the glaze so that this settling does not take place, and that none of these undesirable means be adopted because it is not at all unlikely that they may have a disturbing effect on the final result. Great care should be taken in the sifting of the glaze previous to use for dipping. Glazes used for underglaze colours should be kept separate from glazes used for white ware. Otherwise, it may result in spots of colour appearing on the surface of the finished white. All then that the dipper's duty consists of, is to dip each piece in the glaze mixture, and to handle the same in such a way that any surplus is flung off the surface, and an even coating of glaze is applied. It sounds very simple to describe this, but it is far from a simple process. A really fine dipper is



FIG. 19
HYDRIAC

a great asset to any pottery business. It seems almost in his case that he instinctively knows how best to manipulate each piece of ware so as to produce the perfect article.

In time past much has been said and written, some of it wise and some of it unwise, about lead poisoning in the pottery industry, but a better day has undoubtedly dawned, and this is due in a large measure to the adoption of what is known as fritted lead glaze. It seems that lead in its soluble form is much more dangerous than when it is rendered insoluble by fritting, and the writer believes that gradually throughout the whole pottery industry raw lead will be replaced by fritted lead, thus rendering the dipper practically immune from any danger in this respect.

From the dipper the ware is carried into a long drying chamber, heated by steam pipes, or sometimes stoves, or placed on to a mangle drying machine, which is constantly revolving at the side of the dipper, and which carries the ware through a drying zone and delivers it to the ware cleaners in another part of the room. When dry the ware has to be freed from glaze on the foot by the ware cleaner. Sometimes in the case of figures, birds, and pierced ware of all descriptions, the holes and eyes, etc., have to be freed from any surplus glaze which may have collected there. This would apply to peppers and salts, and many articles of everyday use.

The glost placers then take charge of the dipped ware, and the final process in the actual making of pottery takes place. The saggars used in glost ovens are very similar to those used in biscuit ovens. They are, however, coated on the inside with a film of glaze. Otherwise, suction would take place, and during the firing the saggars would absorb the glaze from the surface of the ware. In glost placing it is absolutely

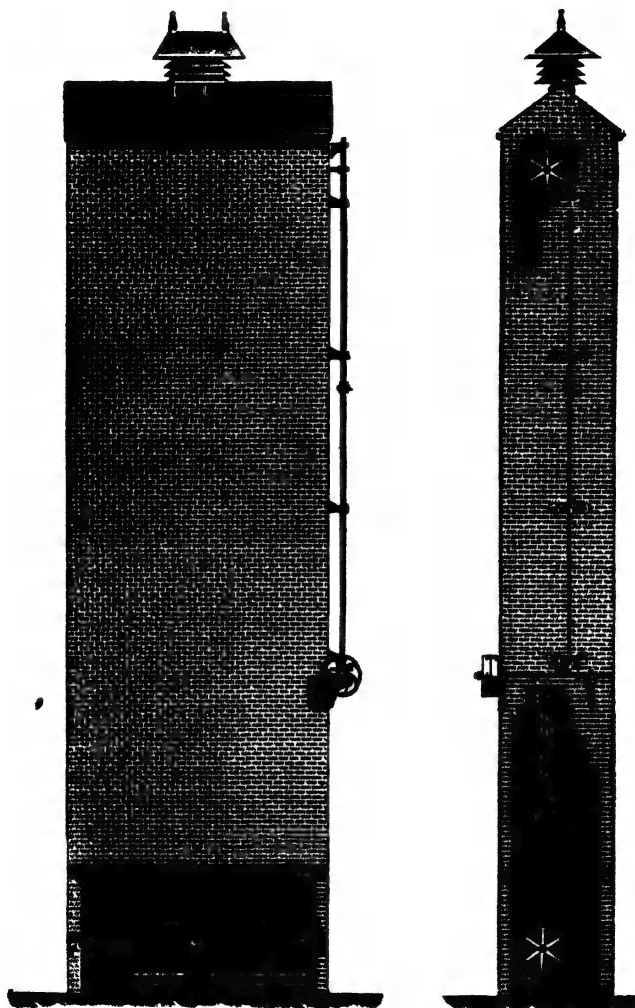


FIG. 20
DRYING TOWER

essential that the pieces of ware should not be allowed to touch each other. Various means have been adopted to overcome this difficulty, particularly in the case of flat. Cranks have the effect of forming a little case which will take one saucer, and can be built up to the requisite height. Box cranks also have the same effect, but are really little boxes each containing one article only. These also can be built up to a given height. Both the cranks and box-cranks are not entirely satisfactory, the former owing to the fact that they seem to render the ware liable to spots and bits, and the latter to the great space they take up and to the reduction in the quantity which the oven will finally contain.

There is, we think, no ideal method of placing glost flat ware to-day. Objections might be pointed out with regard to the rearing method, in which flat is placed on strips and separated at the top by thimbles, having just three points of contact. The objection to this process is that these three points are bound to be more or less visible when fired. Another method is the dottling process, in which the plates are placed on thimbles separated by round or circular frames. Here, again, we have three points of contact. Then there is the banjo sagger; this is a sagger which is really similar to two circles joined together. In each circle it is possible to place a bung of plates or saucers, but the same objection with the points of contact applies here. The manufacturer must, however, use the best possible means for his type of ware, and only experience proves to him which is the best process for his purpose. Expensive pieces like salad bowls are often placed face downwards in order to be kept free from dirt. Dirty ware is the greatest difficulty in the placing and firing of glost ovens. It is well to give as much attention as possible to the quality of the sagger marl and the wad clay used. The

wad clay is used for making wads or rolls of clay which are arranged round the edge of each saggar when the saggar is filled. The pressure of the saggar above on this wad clay forms the saggar into what is practically an air-tight chamber, and this is necessary in order to prevent the fire from playing on to the glaze itself, or the effect would be disastrous. It practically makes each saggar into a little muffle. One can readily see, therefore, that the wad clay must be of such quality that during the firing and cooling processes it must not spit out on to the ware contained in the saggar. Sometimes it happens that the presence of lime in the saggar itself will cause a burst in the saggar bottom, which spreads over the whole of the saggar contents. Probably more loss is caused in the pottery industry through this dirt than from any other cause. Twenty-four to 36 hours is usually taken for the firing of a glost oven. There is no need for the 24 hours delay to drive out any combined water in the case of glost ovens, but the firing should be a continuous advance from start to finish. Sufficient air must be given or the result will be most unsatisfactory. Black, blue, wreathed, and sulphured ware may all be caused by insufficient attention to this very important point. Thirty-six to 48 hours may be taken for cooling, and the glost oven should be ready for drawing.

CHAPTER IX

DESIGNING AND MODELLING

WE think it will be some advantage in approaching this part of our subject if, instead of speaking generally of the whole of pottery designing, we select and describe the designing of a few articles of everyday use. We will, therefore, select a teapot, plate, cup, jug, and a figure.

To begin at the teapot, then. In designing the shape one has first to consider the material in which it is to be made. China has a contraction in firing of one-fifth and earthenware one-twelfth, this means not only that the shape must be more carefully considered for china, but that certain shapes are quite impractical in this body. As a very much larger bulk, however, of teapots are made in earthenware, we will suppose that that is what is required in this case, and then one has a much greater scope in the way of form.

There are certain points to be considered in making a good design for a teapot in pottery, the form should be simple and the spout one that will pour and not drip, a handle that will allow the pot to be picked up easily from a tray full of cups and saucers without burning one's fingers against the body of the pot. A cover that will not fall off when the pot is tilted at an angle for pouring, and the inside of the vessel should contain no grooves or angles that will make it difficult to clean. It should have a grid that is well bored and whose edges are rounded on both sides. Of course, you may have all these requirements satisfied and still have an ugly teapot, but it is certain you cannot have a good one unless these points have attention. The usual method

of making such a pot is to cast it in a mould, because not only is a more perfect thickness obtained, but it is more practical in use and less expensive to produce.

A dinner plate. We suggest you need a rim upon it, not too wide to spoil its usefulness, but deep enough to allow the fingers to get between it and the table to pick it up. There is an idea that the rim of the plate is provided to hold the condiments, but we disagree, the fundamental purpose of a rim is to make it practical to handle. The bottom of the plate should be straight across so as to stand firmly upon the table, and the glazing should be done in such a way as to be smooth, so that one's silver is not unduly scratched or worn in use.

A cup should be simple and pleasant in form with a handle that can be used for picking it up. It should not be too thick, as a thin one is far more pleasant in use, and here it may be said that a machine-made cup is better than a hand-made one, and far cheaper.

A jug should, we think, be fairly large in the opening, wide at the base to stand firmly, and with a good strong handle that gives one security in holding it. It should be very simple in form, and strong, and fairly thick in substance. If the shape will allow the bottom inside to be rounded it is certainly very desirable for cleaning purposes.

In designing a figure for pottery, the first sketch design is very often made in wax, just squeezed without any particular attempt at finish, so that the necessary props for the clay figure may be judged. A very soft clay must be used in building up the model of a pottery figure, and in designing it, it is an advantage to know just where the supports are required, and here one gets the benefit of a preliminary wax sketch. The points to be remembered are that there shall not be too many projecting extremities, which are in constant danger

of breakage, and speaking generally the treatment should be broad and simple. We shall deal next with the modelling and reproduction of such a figure.

Modelling. Having produced a design suitable for its purpose the next necessary process is to produce a model of the design in clay, for from this model the block or original mould has to be made from which the bulk of articles required later are produced.

Let us suppose, therefore, that it is the teapot previously described of which we are about to make a model. Presuming that the article is round in shape, it is usual to turn upon a wheel the body of the pot from a clay block. This block is generally made by the thrower upon his wheel and allowed to harden. The modeller then proceeds to turn the shape of his design, and in the case of this model the clay block may be solid, as it is used only for the purpose of producing a mould. The body having been turned to the required shape the lid is next similarly treated. The spout and handle are then modelled from comparatively soft clay to the required shape, and when this operation has been completed the clay model is in a condition hard enough to be freely handled. It will be understood how necessary this is when it is remembered that from the model a mould has to be made in several parts, each part being without undercut, so that when used for casting the cast may be freely drawn from the mould.

The same method applies for the modelling of a cup or jug, but for a figure which previously we promised to describe, the method is much more complicated.

Let us suppose that the modeller has succeeded in reproducing the design he has in mind, and has built up in clay the figure he wishes to reproduce in pottery. It becomes necessary for the model to be allowed to



FIG. 22
THE JESTER

acquire a certain degree of hardness. The clay should in this condition be about as firm as a piece of well matured cheese. To obtain a mould from this model it becomes necessary to cut it into several pieces. We have endeavoured to indicate what we mean in the accompanying photograph, which shows a model of a complete figure and the same model cut in the necessary parts for a mould to be taken from it, which will be capable of reproducing it in pottery clays. It requires the most careful handling in this cutting down process, as otherwise the potter will experience great difficulty in putting together the reproductions. A very thin knife, something like a painter's palette-knife, is used for this purpose, as the better the joint the more easily the potter is able to reproduce the spirit and pose of the original figure.

It may be advisable at this point to describe the method by which, the figure having been modelled and moulded, is reproduced in pottery. The method generally used is known as casting, and by that we mean that the moulds of the figure to be reproduced are filled with slip, which as previously described in former chapters is clay in liquid state, that is thinned down with water. When the moulds of all the pieces necessary to reproduce the figure have been filled with slip and allowed to remain for, say 20 minutes, a coating of clay becomes attached to the walls of the mould. When this coating is thick enough, the remainder of the slip is emptied from the mould, with a result that the interior of the mould is filled to a certain thickness with a clay wall, which will form all the several parts of the figure. Having been allowed to harden they will further contract away from the mould, which is then opened and the parts removed. The joints of the mould always, of course, leaves a raised

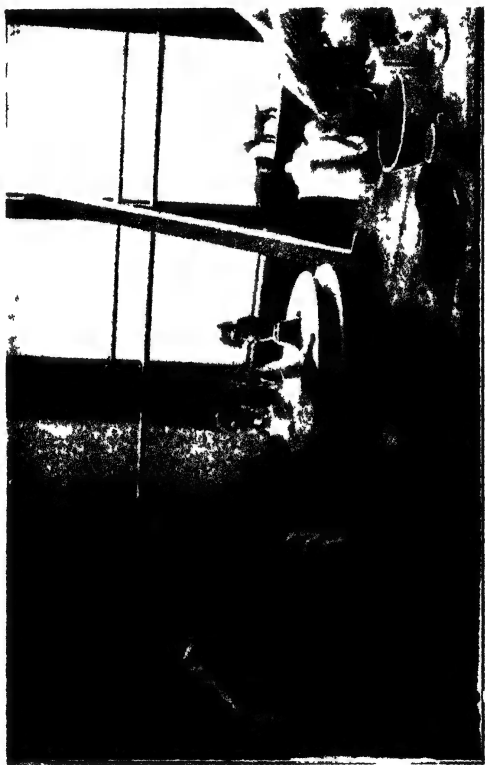


FIG 24
MODELLING

seam upon the clay, and the first business of the figure maker is to remove this seam from each part. The parts having thus been prepared and assembled, the smaller pieces, such as the arms and the head, are attached to the body of the figure, again by means of slip. The two clay joints thus fixed together with slip, which hardens, then become a continuous piece of clay, and when they have all been attached the figure appears in the form of the original model. It requires very successful handling on the part of the maker to reproduce the artist's original design, because not only the body of the figure, but each part is hollow and only of a slight thickness, and would readily, if squeezed, become distorted and out of shape.

CHAPTER X

MOULD MAKING

THE moulds used in the pottery trade are made of plaster of Paris, and are necessary because modern commercial conditions have rendered it impossible to supply, at a competitive price, articles made by the old throwing process on the potter's wheel. This process, though still in use, has gradually given place to the quicker and more economical one connected with the use of plaster moulds. In order, therefore, to understand fully what is meant by "moulds" when they are referred to from time to time, it is just as well to have a chapter dealing with them. Even where moulds are used there are certain hard and fast rules in connection with the manufacture of pottery that cannot be departed from. There are certain shapes that are practically impossible to make successfully. The outline of every piece has to be considered in view of the fact that, especially in the case of china, at some period of the firing, it arrives practically at melting point. Then again, the standardizing of shapes must always be the same. Otherwise you get variations in size and shape in a finished tea set or dinner set. Particular attention has to be paid to flat moulds in order that they may run perfectly true on the jigger-head.

To-day there seems to be a greater appeal for the simple and beautiful outline rather than the elaborate embossment which was prevalent during the early part of the century. It will thus be seen that the position of a modeller producing the original model from which the mould maker has to produce and reproduce his moulds

is not an easy one, and it is always better, if possible, to have your modeller and art director working together in the production of the various articles made. The whole object should be to produce articles of beautiful design that can be manufactured simply, with small loss, and therefore at a price that will appeal to the general public. It then follows that the workman is able to earn a fair wage, the manufacturer a fair profit, and the goods can be sold at a popular price.

Plaster is obtained in England principally from gypsum quarries situated in Derbyshire. This gypsum is mined, ground into a fine powder, and then subjected to heat on a kiln very similar to the kiln previously described for the drying of potters' materials. This process is called boiling because, as it continues, the plaster bubbles, owing to the driving off of the moisture contained therein. It is turned over and over by the use of a wooden rake until the requisite temperature is reached. Then it is allowed to cool and is resifted. In this condition it should be ready for use. Plaster can easily be spoiled in the preparation by imperfect boiling. If overboiled it swells more than plaster which has been correctly treated ; if underboiled it takes very much longer to blend, and these variations prove very deceptive to any but experienced workmen. Sometimes the plaster is so faulty that it will not set properly, and the result may be that it spoils the expensive cases used for making the moulds. It is a general principle in the potting trade that for many cast articles the plaster should be blended so as to form a soft mould. This is done by adding more water. For most other purposes an excess of plaster is added, and this gives a very hard and durable mould which has a long life, supposing always that the plaster is good and the blending has been properly carried out. There is quite an art in

blending plaster. It must not be allowed to stand too long in the jug, otherwise it goes past the proper point for pouring into the case, and is never really satisfactory in use. It will be obvious that only perfectly clean water should be used for plaster blending. It is easily possible in a mould maker's shop to use it partially dirty for this purpose, and the effect would help to increase waste and loss to the manufacturer, for the simple reason that moulds mixed with dirty water seem to rot and perish very quickly.

Mould maker's tools consist of—

Cottles	Files
Scrapers	Gouges
Knives	Callipers
Natch knives	Straight edge
Rifflers	Set squares
Compasses	Whirlers

and in some cases a jigger is required.

A blending jug to hold somewhere about two to four gallons is, of course, the first necessity.

Let us consider, instead of discussing the whole thing generally, the making of one mould from the original model of a jug. When the model comes from the modeller the first thing the mould maker has to do is to see that it has a perfectly true bat fixed in the exact centre of his whirler. This is the base on which the mould has now to be built. The jug as it comes to the mould maker is to all intents and purposes a replica of the article that will ultimately be manufactured and sold, but instead of being hollow it is in solid clay. The mould maker's first task is to fix to this original model at the top and bottom a flanged spare turned out of clay. This spare fits exactly to the edge of the jug bottom, and in the case of the top of the jug the spare is arranged so as to leave just the requisite thickness required in

the finished article. These spares are fastened on to the model by pins which can easily be removed. After this preliminary process the jug is laid on its side in such a way that the seams from spout to bottom on one side, and from top to bottom on the other side, are perfectly horizontal. The jug has to be propped up with small clay blocks until this is accomplished. Then further clay is added, and the clay at the sides is so fashioned as to form a complete half of the jug body. Sometimes the handle is incorporated in this process, particularly in the cheaper grades of china and earthenware, but very often the handle is dealt with separately. The net effect of this process, therefore, as we look down on the model, shows half of it. Plaster bats are arranged at the top and bottom of such height as to give the necessary thickness to the resultant block when the plaster is poured on the model. The outside of the block is formed by cottles tied round with cord, and as soon as the plaster is blended it is poured on to the model, and we have one side of the original in a permanent form. After the necessary time has elapsed to allow the plaster to set, the cottles are removed, and any spare plaster is scraped away, and the final form of one-half of the block is secure. When the plaster has thoroughly set the half block and model with the bats still attached is turned over, the surplus building up clay removed, and the process of building up the model so as to keep the seams perfectly horizontal is again gone through in much the same way as originally explained. We now have revealed to us half the original model, but also in addition to this one side of the block mould. This extends from the seams at a thickness of about $1\frac{1}{2}$ in. or more according to the size of the model. The plaster here has to be scraped and finished, and in order that the top side shall fit

exactly into the bottom side, four natch holes are bored, two on each side into the bottom half of the plaster block. When the sides are built up again, and the plaster is poured on to the model these holes are filled up by the plaster, and form a lock which prevents one side from slipping away from the other. You thus have a complete jug so far as the sides are concerned. The next procedure is the formation of the bottom. It will be easily understood that absolute accuracy must be obtained. This can be done by placing the model and block on to the jigger top downwards. The spare on the bottom already referred to is now removed, revealing the bottom of the original model. This has to be tested very carefully to see that it runs perfectly true on the true bat previously mentioned. When this is ascertained the mould maker proceeds to turn up the newly added plaster block so that it also is true both as regards the sides, bottom, and top. The block mould is now ready for the addition of the bottom.

It ought to be mentioned here that plaster can be prevented from sticking to plaster by the sizing process. This process consists of painting over the plaster surface with a mixture of pure soft soap boiled in water. The surplus of this is carefully sponged away, leaving a film which has to be renewed every time the plaster is poured on to the block or case. In this way the surface of cases are preserved indefinitely. The greater the cleanliness and care the longer the life of the case.

Previous to forming the bottom of the block, natches are bored, three on one half the side and two on the other half. It is necessary to have this distinct so that there is never any query as to where to put the sides when the final moulds are being assembled. The cottle is again wrapped round the whole model and block, plaster is poured on, allowed to set, the spare is



turned away, and in about half an hour the whole article can be separated, the original model removed, and we have a hollow copy of the original, which is the mould maker's pattern. This original is numbered, entered in a book, and placed in the mould maker's store room. From it ~~cases~~ are made which are replicas of the original model plus the necessary spares, etc., to enable moulds to be made in bulk.

Moulds. It sometimes happens that 15 or 20 dozen moulds are wanted of one shape or pattern, and in a case of this sort, after the original block is prepared, probably half a dozen cases will be made from it. The cases also have their special place in the store room, but are, of course, neither so expensive to make nor so important as the block mould. If the block is broken the whole process has to be gone through again from the beginning, namely, modelling, blocking, and casing ; but a broken case can easily be replaced. There are thousands of different models stored away in any large factory, and it is always wise to keep a book recording the position in the store room of such models. Usually blocks and cases are made as hard as it is possible for the plaster to be blended, while the moulds are a little softer, thus if anything has to go it is the mould that will break rather than the original hard case. Some moulds are not made in the comparatively simple way already mentioned, but have to be made in even six or any number of parts, and here the mould makers' art becomes a very interesting and difficult problem. It is probably the most important of the processes of a factory. If the ~~seams~~ are not true, or in the case of flat moulds, are not exact in every detail, so that when a new batch of moulds is sent out there is no variation, the potter when he comes to make his ware from them will be up against almost insuperable difficulty, and the

resultant loss in manufacture will be very greatly increased. The great essential in mould making is cleanliness, and the observation always of certain specific rules which must not be departed from. There is hardly any limit to the shapes that can be made in pottery, but a potter has to consider the ultimate cost, the reduction of losses, and therefore the most difficult articles are generally ruled out as impossible.

CHAPTER XI

SOME TYPES OF POTTERY DECORATION

THERE is, perhaps, no decorative process that requires more technical knowledge than that of pottery. The reason for this being the high degree of temperature at which colours are developed. The enamel kiln is ordinarily fired at a temperature of 800 to 900 degrees centigrade, and the hard kiln to about 950.

The colours used for the decorations of pottery are made with a base stained with metallic oxides, mixed with a suitable flux to fasten them to the ware.

The two ordinary methods of decoration are under glaze, and enamel, i.e. on the glaze. The former has certain advantages for domestic ware as the patterns never become worn or defaced in use, the palette, however, is somewhat limited.

• In underglaze decoration the pattern is put upon the bisque and generally hardened on the ware by firing at a low temperature. This is necessary so that the oils with which the colours are mixed for working may be burnt away, otherwise the glaze which is mixed with water would not adhere to the pottery.

This method of decoration requires very direct work, the artist must know exactly the effect at which he is aiming, as no erasing can be effected.

In a hand-painted job, the design should be sketched on the ware with either a lead pencil or Indian ink, and the colour mixed with pure turpentine applied boldly with considerable weight of colour, this is necessary because although the colour in firing is protected



FIG. 26
AN ARTIST

by the glaze, it has to withstand a higher degree of fire, anything up to 1,100 centigrade.

In commercial work the pattern is frequently printed on the ware and filled in with colours, thus giving a very pleasant effect.

Much greater freedom may be employed in painting on the glaze and the general effect of the work is entirely different from the underglaze process.

It is usual to sketch the design in Indian ink, and it is possible and easy to rub it out and replace it until a satisfactory design has been obtained.

The colours for enamel painting should be carefully ground on a pottery tile with a palette knife and mixed with oil of turpentine, great care being taken to obtain the oil pure and of good quality. The easy working of the colour is much improved by adding a little "fat oil" of turpentine, which gives it a smoother capacity for covering surfaces in applying washes. If it is desired to keep the colour open, the addition of a little—a very little—oil of aniseed will effect the purpose.

It is quite possible to mix some of the colours together to vary the tint, but speaking generally it is advisable for the beginner at least—to paint in pure colour, and obtain the variations by applying another colour over the first in a second fire. This means if the correct combinations are used, transparency and brilliance. It may be necessary to have the pottery fired three or even four times if great depth and variety of colour is required.

Printing is a method by which a considerable quantity of commercial pottery is decorated. The pattern is applied to the ware generally in outline, and is then elaborated by the addition of other enamel colours, a good deal of the work thus being handwork. It is quite obvious, of course, that if the design instead of being printed were



FIG 27
PRINTING THE PATTERN ON CUPS AND SAUCERS

drawn by hand, the ware could not be produced at a price to meet the needs of the large mass of people. It is, however, a perfectly legitimate pottery process, and one of the very early ones used in the decoration of English earthenware and china. Liverpool and Worcester were the first English factories to use this method, and it was known as transfer-printing.

Lithography is now used very considerably, and is capable of producing very pleasant and economic results. The designs are drawn on stone in a grease paint, a different stone being used for each colour, or each variation of the same colour.

The pattern is then taken off the stone on thin paper, every stone contributing its share of the design according to the number of colours used in it. When the whole of the colours are thus transferred to the paper and allowed a few days to dry, the paper is covered with a transparent varnish, which soon hardens and allows the "sheets," i.e. the design on paper, to be stored for use as required. Much very shocking design is produced by this method, but also very choice and neat ones. Generally it may be said that designs to be good for this style, should not ape painting, but should be characteristic of the process, the outlines neat, clear, and well defined, and the colours flat. There is no other ceramic decoration for domestic ware capable of giving so multi-coloured an effect at such small cost, and it is therefore very largely employed.

The design is applied to the ware by cutting the paper approximately to the pattern, and after sizing the ware applying the paper to the correct position on the article, it should then be pressed on with a rubber, and after a short time washed off in water, when the design will be found attached to the ware. It is then fired in the enamel kiln.

Many of the more simple and artistic processes, although not used extensively in modern pottery production, are of the greatest interest to the pottery student.

Slip painting is a delightful way of obtaining broad and simple effects, and as a medium is extremely pleasant and easy in use. The slip about the consistency of cream is painted on the clay before the bisque fire, and may be applied with a sable or hog hair brush, very much like oil colours are put on a canvas. It is, however, absolutely necessary that the pot itself must be in a "green" condition, about so hard that one's nail will easily cut out a portion of the surface; otherwise the applied pattern will all peel off in firing, the result being a complete failure.

The article should not be soft enough to bend, but should show no powdery white on either surface or edge. That is a reliable test. The slips are stained with metallic oxides, and a very fair range of colours in low tones can be obtained. For bold work it is an excellent and effective process.

CHAPTER XII

ENAMEL KILNS

HARDENING-ON and enamel kilns are very similar in their construction. These kilns are of the muffle type, i.e. the flames are not allowed to come in direct contact with the ware, but run underneath and round the sides of the kilns from the fire mouths along flues so arranged that they are equally distributed over the whole portion of the kiln as near as is practicable. The muffle may measure anything from 3 ft. high to even 10 ft. or 12 ft., and the same in length, with a width of about half the length. The mouths are arranged at the side, and level with the bottom of the kiln chamber itself, and flues arranged as previously mentioned carry the heat into a tall cone, finishing in what might very simply be called a bottle-shaped chimney stack. The opening to the muffle is closed by iron doors having two spy holes, which enable the fireman to inspect the inside of the kiln from time to time. The iron doors are protected from the heat by a firebrick lining. All crevices are stopped up with china clay softened down to the consistency of a paste, but this stopping up must never be carried out until the firing has been in progress sufficiently long to expel all fumes from the kiln. Coal is used for the raising of the necessary temperature, and the firing usually takes 10 to 12 hours. Great care has to be exercised in order that sulphurous fumes may not penetrate through any cracks or crevices in the side of the kiln, or disastrous results would ensue. The muffle of a new kiln is always thoroughly lime-washed before use. Afterwards it may be found necessary to stop

up any cracks which have developed in the brickwork of the kiln with the aid of china clay, again washing over with lime wash.

In the case of china these kilns usually contain from 400 to 500 dozens of ware. In spite of every effort to construct the kilns so as to obtain uniform temperature throughout the muffle, it has been found in practice that this is almost impossible. Experience has shown that in the actual placing of the ware, great care must be taken. It is, therefore, necessary to put only those articles that will not suffer from any excess heat in the danger places, owing to the fact that certain colours allow for a very slight margin of temperature, 20 degrees in excess of the correct heat being sufficient to destroy the tint. As previously mentioned, the temperature required for the firing of enamel colours varies from 800 to 900 degrees centigrade. This heat is sufficient to cause the glaze to soften slightly on the surface, and methods have had to be invented for the placing of ware in the kilns in such a way that no two pieces are allowed to touch. In order to prevent this contact, and to enable the manufacturer to fill the kilns to the greatest advantage, various articles made of a hard semi-vitreous body, and known in the trade by such names as "butterflies," "dumps," "thimbles," and "stilts" are used. They are made in many shapes, and in such form that while separating the actual ware, only the finest point comes in contact with the glaze. For better classes of ware, and expensive pieces, it is usual to place the ware in cranks, which are really skeleton cases, each small case containing one piece, and one may even go so far as totally to enclose the piece in a small case or box crank of its own. Thimbles are also used much in the same way as already explained for placing ware in the glost oven. Naturally, the use

of these articles is quite an expensive part of the manufacturing processes.

Modern research has resulted in the introduction of various types of continuous kilns for the firing of enamel colours. The "Dressler" and "Climax" may be cited as types of these kilns, which have proved very successful under the right conditions, but there are in use simpler types which only cost a few hundred pounds, and are capable of an output of 6,000 dozen of ware per week, resulting in a saving of 50 to 75 per cent of fuel as compared with the use of ordinary kilns. One other great advantage in the continuous enamel kiln is that there is great freedom from dust and kiln dirt. Probably, however, the greatest improvement effected by this method of firing is in the colours. This is due to the fact that the colours are brought up to the required temperature in a shorter period of time. This gives the desired brilliancy, and avoids to a large extent an excess of volatilization from the colours. A prolonged firing in nearly every case tends to make an enamel colour become very dry, due to the reason explained above. No great space is required for a simple kiln of this description, a room 15 yards square being quite adequate for the purpose, and it can be highly recommended to any potter who is only satisfied with the best possible.

In cooling a kiln the stoppings from round about the doors may be removed a few hours after the fires are out. Sometimes it is necessary to cool very quickly, but this results in dunting, and is thus a source of increased loss. Especially where very large articles are placed in a kiln as much time as possible must be allowed for the cooling process.

The kiln records, with particulars of the count, the percentage of loss, and the fuel used, is required.

All the ware that has been paid for and placed in the kiln should be accounted for. The value of a record of this description increases as the years go by.

Kiln losses are caused by a number of faults which are common to the trade—

1. OVERFIRED. The tint of the colours in this case will sometimes be spoiled hopelessly, and may even be crazed or blistered.

2. UNDERFIRED. Here the colours will be short of the necessary brilliance, and in the case of gold, although there may be the brilliance, it would be quite easy to rub it off with the finger.

3. SPIT-OUT. This type of fault is very difficult to control, the reason being that it is due to so many causes. It is often put down to dampness in the ware itself, this assumption being due to the fact that old white ware that has been decorated often develops this fault during the kiln firing. Personally, we have doubts as to this assumption being correct, but one thing is certain, it is always better to use ware for decorating that has not been lying about for any length of time.

4. SULPHURED WARE. This may be due to bad stopping of the muffle, or insufficient lime-washing, or even to some fault developing in the muffle during the firing which was unobserved when the kiln was being prepared. It may also be due to a faulty method of bating (stoking up).

It is always necessary in the firing of pottery ovens and kilns to allow sufficient air space over the top of the fuel. Otherwise sulphurous fumes in excess are almost capable of penetrating through the most perfect type of muffle. Dirty ware, chipped ware, kiln dust, rubbed ware (i.e. colours rubbed off by careless handling), are all kiln faults that are due to carelessness, and

should be closely checked by the manager of the department.

Polishing. If a kiln happens to be at all overfired, it often results in stilts leaving marks on the surface of the ware which are very objectionable. These marks have to be removed by experienced workmen called "polishers." The polishing is done on a lathe driven by machinery. The polisher is supplied with a series of grinding and polishing wheels, some of them made of carborundum having various grades of fineness, and also wood and cork wheels. It will thus be seen that an expert workman, with the aid of these tools, can remove all slight faults, and bring back the surface of the ware to its former condition.

CHAPTER XIII

COSTING

Costs of Production are always difficult to arrive at in the pottery industry. The principle adopted is fairly simple, and may be more easily understood by consideration of the following details required in arriving at an estimate for any given article—

- Clay
- Moulds
- Making
- Clay loss
- Biscuit firing
- Biscuit loss
- Glost firing
- Glost lost
- Dead expenses
- Net cost of white ware.

If decorated the following particulars have to be added—

- Cost of colour
- Printing
- Gold
- Kiln firing
- Kiln loss
- Dead expenses
- Net cost.

To this is added the profit.

It must be said, however, that in no case can these figures be regarded as absolutely accurate. It has been said many times that it is impossible to get at the exact cost of making pottery ware. Only experience over a

number of years can guide one as to the possibilities as regards any particular type of decoration, but this experience along with the method outlined gives results that for general use are to all intents and purposes satisfactory.

The getting up of orders on a factory is a very important part of the organization. Many systems are in vogue, but it would be difficult to describe in writing the most satisfactory type of system. So much depends upon the personality of the management, and the care and attention given to the orders in hand.

A pottery is very much like a human being. If one part goes wrong it affects the whole. A stoppage in any part may bring the whole organization to a standstill. Losses, unless carefully checked, may creep in to an alarming extent. It is absolutely essential, if satisfactory results are to be obtained year by year, that all losses should be carefully checked—clay losses ; biscuit pitchers per oven in dozens and weight ; the percentage of glost losses divided up into its various types, lump, thirds, seconds, oven ware, cracked, and broken, returns to the dipper. The percentage of good out of the glost oven varies in different factories, but it is always of great value to be able to compare the losses of one period with another.

Another item of great importance is the percentage of wages as compared with the net packing. A simple balance sheet can always be made by taking wages and all purchases including rates, rent, etc., and deducting them from the net packing. Care, of course, must be taken here to see that nothing is left out. Otherwise the result is bound to be wrong.

Stock-taking must take place every year, or more often if necessary. It has a particular value in that it checks losses which take place in works utensils, it shows if

there is any increase in the bulk of materials stored about the place, or if there are any odd lots of ware in the finished warehouse that have been allowed to accumulate. All these things are just the business side of the industry. At the back of it all one feels the mystery, charm, and elusiveness of this fascinating and delightful trade. The instinct to make pottery passes on from father to son from generation to generation, both among the employers and the craftsmen. Many of the results obtained are purely through that instinctive knowledge which comes through familiarity with any given process. The achievement of some new ideal either in decoration, body, or glaze, tested and proved in the firey heart of a potter's oven, always adds its charm and zest to this most complicated and yet enthralling industry.

GLOSSARY

ARKS. Storage bins.

BASALT WARE. Similar to Wedgwood's black ware.

BEDDING. Method of placing flat ware employed by china makers.

CHUCK. See page 62.

CLAMMINGS. Entrance to oven.

COTTLES. Leather strips of various widths.

DRYING KILN. See page 43.

DUNTING. Splitting caused by inrush of cold air.

EXPANSION CHAMBER. Empty enclosed space above drying stove.

FETTLING. See page 66.

GREENHOUSE. Place where clay ware is stored before firing.

JASPER WARE. Wedgwood blue ware often decorated with raised white figures.

NATCH. Underpart of saucer bevelled to fit brass head of making machine.

PARIAN. Ivory Heraldic body as Goss.

REDUCING FIRE. Smoky impure fire—opposite of oxidizing.

RINGS. Grooved circular pieces of clay which keep the cups straight during firing.

RUNNERS. Blocks of chert stone. See page 36

SAGGARS. See page 80.

SALT GLAZE STONEWARE. Glazed by salt thrown in the hot fireplaces, thus creating fumes which glaze contents of oven.

SET. To become hard on settling.

SLUG IRON. Iron strengthening band, keeping grinding pan arms in position.

VITROSITY. Like glass.

VOLATILIZATION. Colours improperly treated sometimes evaporate.

WREATHS. Marks due to faulty workmanship.

APPENDIX

THE FIRE HAZARDS ASSOCIATED WITH THE MANUFACTURE OF CHINA AND EARTHENWARE

BY THOS. HARTLEY, F.C.I.I.

LITTLE needs to be said about what are known as Common Hazards. The materials actually used in the making of pottery are none of them inflammable, and the ordinary common-sense rules apply to the lighting and heating arrangements, with certain exceptions which will be mentioned later. The first six chapters of this book deal with wet processes almost entirely, and not until the "drying" stage is entered upon do we reach the serious special hazards.

Stamping. Some few articles are stamped from plastic clay (e.g. small fruit dishes, stilts, spurs, and the like), while tiles and pieces of electric porcelain are stamped from clay dust. Paraffin, or a mixture of paraffin and tallow, is often used for the cleaning and lubrication of the dies in the stamping-press, and some little risk arises both from the use and storage of such materials. Where plastic clay is used and the stamping-presses are many, the risk is more serious. Each worker has a shallow vessel containing oil, and in time a good deal gets spilled on to the benches, which should be frequently cleaned; the vessels should be emptied and the stock cleared into storage each night.

Drying arrangements vary greatly, and it is only possible to refer to a few in detail. Drying of clay ware is carried out either in a separate room, or in a "drying

stove," not always easy of access. The heat is derived usually from a stove-pot or steam-pipes, sometimes from a fire-heated flue, and occasionally from hot water-pipes, or even hot air ducts. If a separate room is used the ware is carried in on loose shelves or "work-boards," which are placed on wooden supports or stillaging lining the walls. Such a room has to be cleaned out every night to comply with the Home Office Regulations, and this should prevent the accumulation of refuse on the floor. When a stove-pot is used it is placed about the middle of the room ; great care should be taken to protect the floor, and to prevent either shelving or stillaging coming near the pipe. A good deal of heat is needed to dry the moist clay, and it is no uncommon thing to see such a stove red-hot. If pipes are used they are led under the stillaging a few inches from the floor, and in flue drying the flues take the same course. Flues are apt to deteriorate ; iron stillaging is objected to on account of the danger from rust. It is important that all woodwork be fixed well clear of the flues and firing-place.

Drying-stoves wholly or partially enclosed with woodwork are very common, and are often carried in a range down the centre of a long room. Many are of the revolving type like huge turnstiles (called "dobbins" —see illustration on page 78), but there are many types. The feature to note is the large amount of woodwork in construction, and the fact that it is so dry as to be readily ignited. Many serious fires have originated in these steam-heated stoves, but, as a rule, the whole range is destroyed and the cause of the fire untraceable. Being more or less closed in they are not easy to examine, and may be used for the deposit of any rubbish the workpeople want to get rid of, e.g. string and greasy lunch-papers.

The "drying tower" (see page 100) is steadily growing in favour as an adjunct to the dipping house, and is practically free from risk.

Experiments are sometimes made to utilize the waste heat from ovens and kilns of the continuous type, and any such cases require very careful examination for inflammable material in proximity.

Ovens. A description of the ordinary potter's oven is given in Chapter VII, and it is there shown that the firing process covers a period of about three days. The maximum temperature reached varies with the kind of ware, and in the "glost" oven the heat is always less than in the corresponding "biscuit" oven. Manifestly, however, in any process requiring a temperature of over 1000° C. there must be serious fire risk, *unless the heated air and all products of combustion are confined to their proper channels.* The oven and hovel together are intended so to confine them, and in the case of a new structure this intention is often realized. It must be noted, however, that the alternate heating and cooling involves alternate expansion and contraction of the oven, and this may lead—does in fact lead—to the cracking of the brickwork, even though it is held together by "bonding irons." A further point is that often the cooling of the oven—more especially the glost oven—is assisted by the partial breaking down of the brickwork (or "clammings") with which the oven doorway is closed when under fire. The heat is then *no longer confined to its proper channel*, and very serious risk may arise, the degree of risk depending upon the relation of the oven and hovel to one another, and to the adjacent buildings.

In one type of oven the hovel is quite a separate structure, and the fireman works in the space between the two. Usually, such an oven stands quite outside

any buildings, and is only connected by a doorway opening from the building into the hovel. It is much the safest type of oven ; there is, indeed, very little risk so long as the separation of the two structures is maintained. Sometimes, however, after the clammings have been partially broken down the oven and hovel are united by a temporary tunnel (or "fleck") carried from the one doorway to the other. The space is thus bridged over, and the heat may be conducted through the hovel doorway into the adjacent building.

In other types of ovens, known variously as "cone" and "skeleton" ovens, the hovel is not a detached structure ; it may be built close up to the oven or actually on the same foundation. In such a case—which may be distinguished as a "combined oven and hovel"—special hazards arise. If the combined structure passes only through a shed building, and the shed roof is lofty, there is little risk except to the roof itself ; if that roof has a fire-proof ventilator over the oven doorway which can be opened when the cooling begins the risk is reduced ; better still, of course, if the roof is fire-proof. It is, however, quite a common practice to carry ovens of this type through storied buildings, in which case the room on the ground floor into which the ovens open is used as a "saggar house" or "placing house." When a hole is knocked in the clammings the heat escapes, and the space between the hovel and the oven should be sufficient to allow of its being conducted in safety upwards. If the space is not adequate, the heat plays upon the ceiling of the placing house, and if that ceiling is not fire-proof the security of the building will depend entirely upon due care being taken to postpone the breaking down of the clammings until the oven has cooled to a safe point. Even if the ceiling is fire-proof—nominally—it may be found that there are

holes to admit of the working of the "damper" chains, and through these the heat may get access to inflammable material on the floor above.

In the upper part of a storied building containing an oven there are also special hazards. If the roof timbers are supported by the hovel they should be properly corbelled, and the floor timbers should be carried on an adequate string-course. No woodwork should be in contact with the hovel, and special care should be taken in this connection in the neighbourhood of the oven shoulder. The heat from the "shoulder holes" plays on the inside of the hovel and creates a very dangerous zone.

Fires have also been caused by the heat from the "trial holes" (see page 90). Sometimes these holes are too near a non-fire-proof ceiling, and the loose bricks with which they are supposed to be stopped are not always replaced during the period of cooling.

The ovens considered above are "up-draught"—the common type—and the smoke, etc., during firing, is carried out of the oven through holes in the crown. Down-draught ovens are, however, also used, and in these the smoke rises first to the oven crown in which the holes are closed by dampers, then down between the "bungs" of saggars, under the floor of the oven, and thence up flues in the outer shell of the oven, passing finally out at the dwarf chimneys built at the top. These flues bring the heat nearer the outside of the brickwork, making precautions as to woodwork in contact even more desirable. Where several down-draught ovens are built together the outer hovel is sometimes dispensed with, and they are connected by an underground flue with a separate chimney stack.

The newer types of oven, the tunnel (e.g. the "Dressler" and the "Marlow") and the chamber (e.g.

the "Shaw"), are usually erected in a special shed building, and provided there is no woodwork in proximity there is little risk. Tunnel ovens and kilns are nearly always fired with producer gas, and the usual risks in connection therewith must be taken account of. The same remark applies to chamber ovens, which are generally built in a series of about twenty. Here there is no fixed firing zone, as in the tunnel, but the chambers are under fire in succession, the waste heat from the one under fire being utilized to warm up the next in series. An important point about all these continuously fired ovens is that somewhere there is necessarily a flue which is rarely cool. Heat applied continuously will at last get through a thick body of brickwork, and examination is necessary.

Kilns. Where a "slip kiln" is used (see pages 44 and 52) it is only necessary to guard against woodwork in proximity.

In some potteries certain of the glaze materials undergo the process of "fritting" (see page 99). The "frit kiln" is only occasionally used, but the temperature reached is high, even higher than the biscuit oven. It is usually in a separate shed, and the danger again arises from woodwork in proximity to the kiln or in contact with the chimney.

A kiln known as a "hardening-on" kiln is often used in connection with the printing house. It is fired at a low temperature to drive out the oil with which the colours are mixed. The risks are similar to those of the enamel kilns but relatively less.

The principal kilns are those used for the firing of ware decorated on the glaze, and these "enamel kilns" are described in Chapter XII. They are fired at a lower temperature than the ovens, but the heat is quite sufficient to make them a serious hazard. The time

of greatest danger is after the kiln doors are opened to assist the cooling ; a considerable body of heat then escapes, and though the risk is less than that of an oven similar precautions are needed. Usually such kilns open into a small shed, which should have a fire-proof roof or ventilators. If a kiln opens into a storied building it may be possible to protect a non-fire-proof ceiling, and so reduce the hazard.

Short tunnel kilns are sometimes used to fire decorated ware, and woodwork in construction should be examined. A more serious risk arises from the circular continuous kiln (e.g. the Climax) in which the fires may be maintained for weeks together. Such a structure should be kept in good condition, and care taken that the flat top of the kiln is not used as a dumping place for any inflammable material.

Decorating. A decorating process in which many hands are engaged is printing, and associated with this are certain minor hazards. The colours used are, of course, metallic, but the medium is a special " printer's oil " made from such ingredients as linseed oil, tar, rape oil, and resin. The mixing of these by boiling is a process which is attended by great danger, and should not be allowed in any building. In the printing shop a hot table or stove is required on which the copper plates and colours are manipulated. If this stove is fire-heated, protection of the floor is called for. The copper plates when done with are cleaned usually with spirits of tar, which is rubbed off with sawdust kept in a wooden box. This sawdust in time gets impregnated with oil, and may easily be set on fire. In the transferring shop where the printed tissue is cut up and applied to the ware, there is a considerable litter of greasy paper, which should be cleared away and burnt.

The colours used by the painters and enamellers are

mixed with spirits of turpentine or fat oil of turpentine, and the presence and storage of these materials are points needing attention.

Gilding introduces another element of risk. Gold and gold-colours cannot be wasted. Any surplus is cleaned off the ware with rags, which are also used to clean the palettes and brushes, etc. It is usual to allow these rags to accumulate until it is worth while to burn them for recovery of the gold. As the rags accumulate they become liable to spontaneous combustion. They should be kept in a metal or brick bin on a fire-proof floor.

Groundlaying by means of dry colours, and aerographing, in which process the colour is sprayed on to the ware, are both done in front of hoods connected by wooden trunking with an exhaust fan. Cotton wool is used for cleaning, and this is apt to get drawn into the trunking when it may accumulate on the fan bearings. Fires have been traced to this as a probable cause.

Packing. The material commonly used for packing is straw, and many fires have originated in this department—usually the straw store is the actual place of origin.

In the packing house itself the only inanimate source of risk is to be found in the lighting. Gas lights should be enclosed in a glass lantern maintained in good condition. Smoking should be rigidly prohibited in proximity to the packing house.

Straw store fires have usually occurred during the night or the week-end, and many have taken place under conditions which pointed to spontaneous combustion. Foreign baled straw was at one time under serious suspicion in this connection. Certain precautions are suggested by experience. A straw store should be adequately ventilated, and that in such a way as not

to allow entry of sparks from outside. New straw should never be dumped upon the old—the bottom layer in such a store becomes in time simply a mass of decomposing refuse. A straw store should be large enough to admit of each half being used alternately ; it can then be cleared to the ground level and no refuse accumulates.

The windows of both packing houses and straw stores should be maintained intact ; wired glass is useful in this connection. Any pitch hole should be kept closed.

Lamps. Finally, reference should be made to the portable lamps often used to light the inside of the ovens during “setting in.” “Torch lamps” are made of metal with a spout from which emerges a tow wick ; a thick oil known as torch oil is burned, and as long as the lamp remains in the oven there is no risk. These lamps, however, are apt to be taken away to light some dark gear place or wheel race, and this improper use has resulted in fires.

INDEX

ASH Bone, 40
— Soda, 77

BALL Clay, 16, 22
— — Deposits, 32
Bedding, 88
Blungers, 47
Blocking and Casing, 106, 114
Body Mixing, 21, 45
Bone, 22
Bristol Factory, 20
British Pottery, Old, 2

CASTING, 76, 108
Chelsea Factory, 19
Chemistry of Potting, 24
China Clay, 16, 22
— —, Winning of, 28
Chinese Pottery, 5
Clay, Press, 52
Clay, Wad, 103
Cleaning, Flat, 94
—, Hollow-ware, 94
Cost of Production, 131
Cottles, 115
Counting Out, 84
Cranks, 102, 127

DECORATING, 120
Designing, 104
Dipping, 97
Drying, 85
— of Dipped Ware, 99
Dutch Pottery, 12
Dwight, 15

EARTHENWARE, 22
Egyptian Pottery, 1
Elers Brothers, 16
Enamelling, 120
English Pottery, 18

FAIENCE, 11
Felspar, 16, 22
—, Preparation of, 41
Firing, China Biscuit, 92
—, Earthenware, 93
—, Glost, 99
Flaxman, 18
Flints, 22
—, Preparing, 36
Flinting, 88

GERMAN Pottery, 12
Glaze, Preparation of, 41
—, Fritted Lead, 99
—, Use of, 97
Greek Pottery, 3
Greenhouse, 85
Grog, 82
Gypsum, 113

HANDLING, 64

INSCRIPTIONS, 14

JIGGER, 70

KAOLIN, 7, 28
Kilns, continuous, 128
—, Drying, 31, 43, 52
—, Enamel, 126
—, Plaster, 113

LININGS for Cups, 57
Looker to Ware, 58
Loss, Causes of, 96
—, Record of, 128

MAGNETS, 45, 50
Majolica, 10
Marl, 80
Milling of Materials, 35
Modelling, 106

- Moulds, making, 72, 116
 ——— for handles, 66
 NATCH, 72, 116
 OVEN, Description of, 85
 ———, Glost, 103
 ———, Temperature of, 22, 93, 120, 122
 PALISSY Bernard, 12
 Parian, Grinding, 43
 Persian Pottery, 9
 Petuntze, 7
 Placing, Biscuit, 85, 87
 ———, China Flat, 88
 ———, Glost Oven, 99
 ———, Hollow-ware, 88
 ——— Kilns, 127
 Plaster, 77, 112
 Plymouth Factory, 20
 Polishing, 130
 Press Cloths, 52
 Printing, 122
 Pugging, or Wedging, 74
 Pug Mill, 35
 RUMBLER, 95
 SAGGARS, banjo, 102
 ———, Glost, 99
 ———, Green, 82
 ———, Making, 80
 ———, Number, 90
 Sand, Placing, 93
 Seger Cones, 93
 Setters, 88, 90
 Sifters, 47
 Slip, 76
 ———, Preparing, 125
 Sliphouse, 45, 47
 Spreader, 70
 Stilts, 127
 Stock-taking, 132
 Stone, China, 22
 ———, Analysis of, 32
 ———, Kinds of, 33
 Stoves, Drying, 78
 Swansea Factory, 20
 TANAGRA Statuettes, 5
 Teapots, 104
 Thermoscope Bars, 93
 Throwing, 56, 106
 Toft Ware, 14
 Tools, Handler's, 66, 68
 ———, Mould Maker's, 114
 ———, Thrower's, 64
 ———, Turner's, 60
 Trials, 90
 Turning, 58
 Turpentine, 122
 UNDERGLAZE, 120
 Ushabti Figures, 1
 WAREHOUSE, Biscuit, 94
 Wedgwood, Josiah, 18
 Wheel, Potter's, 3, 62
 Whieldon, 17
 Wood of Burslem, 17
 Worcester Porcelain, 20
 Wrotham Ware, 13, 14

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